Popular Astronomy.

Vol. XXIII, No. 1. JANUARY, 1915. Whole No. 221

THE LICK OBSERVATORY-CROCKER ECLIPSE EXPEDITION TO BROVARY, RUSSIA.*

BY W. W. CAMPBELL AND HEBER D. CURTIS.

Though this powerfully equipped eclipse expedition shared the ill-fortune of several other large eclipse parties in Russia in its failure to secure any results because of unfavorable weather conditions, a description of the camp, the equipment, and the proposed observations may not be without interest, and it should be a matter of record.

It is superfluous to express our gratitude to Regent William H. Crocker for the gift which made the expedition possible; through the gifts of Mr. Crocker especially, his brother, and of Mrs. Phoebe A. Hearst, the Lick Observatory has been enabled to send well-equipped expeditions to observe all the more important total solar eclipses since its completion in 1888, resulting in a collection of eclipse observations which is doubtless the most extensive in existence. For a number of eclipses in this interval of twenty-six years no attempt was made by the Lick Observatory to send expeditions because of known poor chance of success; and in nearly all these cases the lack of success by the astronomers who went has shown the wisdom of our abstention. That the present expedition cannot claim the success which seven out of our eight earlier expeditions experienced must be accepted as one of the "fortunes of war."

Accurate information bearing on the probable weather conditions at various possible sites along the path of totality was unusually difficult to secure. Published records seem to leave no doubt that the probabilities of freedom from cloud were better the farther south one went, the cloudiness factor ranging from about 6.8 in Sweden and Riga to 2.3 in the Crimea, on a scale of ten for total cloudiness. It was absolutely essential to be as near as possible to the central line for the observations to be made with the moving-plate spectrograph. The lowlands and other unfavorable conditions along the central line in the Crimea, and

* Reprinted from Publications of the Astronomical Society of the Pacific.

the advantages of nearness to a large city (other things being equal), finally led to the tentative selection of a site to be located as near as possible to the central line where this line passed through the small town of Brovary, some twelve miles northeast of Kiev, in the Government of Chernigov. Also, because of the fundamental requirement as to position on the central line, it was necessary to decline, with great regret, several very kind offers of sites. Mr. Grefs, Court Chamberlain to the Czar, with characteristically generous Russian hospitality, offered us a site on his country estate at Stavidly, a hundred miles, more or less, south-east of Kiev: the party of eight would be his personal guests, and he would supply all the labor and local transportation we needed. But the distance of Mr. Grefs's estate from the central line (13 kilometers) compelled us regretfully to decline this exceedingly generous invitation. That given after we reached Kiev by the Lord Mayor of Kiev to locate on his beautiful grounds, and Professor Vogel's offer of a site in the large enclosure about the Kiev Observatory, were declined for the same reason.

In addition to the instruments, a full equipment of camp furnishings, supplies, and staple foods was taken, repeated experience having shown the great increase in comfort and efficiency to be gained by making a large eclipse camp an independent unit, with no need to rely upon local accomodations or sources of supply. The freight shipment, amounting to about four and a half tons, went by the steamer "Czar" of the Russian-American Line direct to Libau, Russia, which was reached on July 8. It has been our invariable rule to have some member of the eclipse party accompany the freight shipment throughout its entire course; this has often saved serious delays and inconveniences. Mr. Curtis accordingly accompanied the freight. It was planned for him to select a suitable site to the north-east of Kiev as close as possible to the central line, at which point Mr. Campbell and the rest of the party would later join him, travelling via Italy and Austria.

Tne Russian Government had granted to foreign eclipse expeditions free entry for the instruments, provided none were left in Russia, free railway transportation of the instruments, and half-fare passenger tickets. The customs concession was interpreted rather strictly, so that more examination was deemed necessary by the officials at Libau than we had expected, but the officials showed the expedition every possible courtesy.

Mr. Curtis reached Kiev on July 11. The search for a suitable location proceeded rather slowly, as this was the summer vacation season, and nearly all officials and scientists who might be of service were away. However, invaluable assistance was rendered at this time and throughout our stay by several members of the Kiev Circle of Amateur Astron-

omers. To these gentlemen, in particular to Mr. Nicolas Zenchenko, the able President of this Society, and to Mr. Ivan Iliinsky, a prominent member of the Society, our heartiest thanks are due. During the days spent in the selection of the camp, through the troubled and changed conditions brought on by the war, and until our final departure from Kiev, Mr. Zenchenko and Mr. Iliinsky placed themselves unreservedly at our disposal, and were always ready to assist or advise.

The site selected was the Datcha Lavrovskavo, a fine country estate belonging to Judge Lavrovskoy, situated on the northern edge of the village of Brovary, almost precisely on the central line, as corrected by the English astronomers on the basis of recent observations of the moon's motion. The estate was unoccupied, as Judge Lavrovskoy had been transferred to another district some time before, but by a very fortunate coincidence Madam Lavrovskoy happened to be staying there for a few days, and arrangements for its rental were made at once. We are grateful for her courtesy in allowing us to occupy this fine site and for her assistance in arranging the first details of our occupancy. The Datcha comprised eleven acres, all enclosed, an excellent two story residence, barns and out-buildings, cellar, conservatory, and even a small observation tower. A few hour's work converted the half underground winter section of the conservatory into a very convenient dark room. There were many fruit trees, some larger timber, and a lawn in front of the house which offered an ideal site for the instruments.

Tents had been taken for the camp, and it had been planned to construct a kitchen tent, a large dining tent, and a dark room, but the fortunate location at the Datcha made all this unnecessary; a few tents were put up for the younger members of the party who preferred to sleep in true camp fashion, and for work tents. Brovary is a typical Russian town of perhaps three thousand inhabitants, with unimproved dirt streets whose condition becomes indescribable after a heavy rain. A fine military road and a motor tram line connect it with Kiev. Kiev is a thoroughly modern city of over half a million inhabitants, picturesquely located on high bluffs along the Dnieper river. The view of the gilded domes of its many churches and cathedrals, and the panorama of river and plain to be seen from the open-air restaurant of the Kupetchky Sobraniya (Merchants' Club) on a bluff overlooking the Dnieper, are very fine.

The freight was taken out to the camp on July 18 and unpacked; Mr. Campbell and the other members of the party arrived on the 21st. The party numbered eight; Director Campbell and Dr. Curtis; Mrs. Campbell and her mother, Mrs. Elizabeth Thompson; and, in the capacity of voluntary assistants, Dr. Campbell's three sons, Wallace Campbell

(Harvard '16), Douglas Campbell (Harvard '17) and Kenneth Campbell (Hotchkiss '17); and Mr. Charles F. Brush, Jr., (Harvard '15). Within three days the living arrangements were perfected, and the real work of preparing for the eclipse was begun.

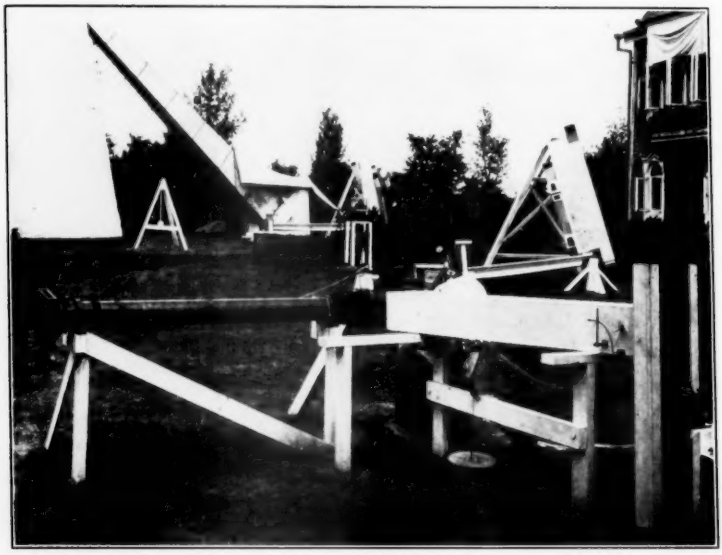
With the four energetic and active young Americans as helpers the work of setting up the instruments proceeded very rapidly; in fact, as time progressed, it became increasingly difficult to provide work for our insatiable young assistants. So rapidly did the work go that the last two weeks were easy, and everything could have been in readiness ten days before the eclipse. Mrs. Campbell, as at several previous eclipses, was a most efficient "Secretary of the Interior", administering to our material wants with the assistance of a large domestic staff, and seeing to it that our drinking water was adequately boiled and sanitarily irreproachable. All in all, our life at the Datcha Lavrovskavo was a very pleasant one, and the members of the party will always remember it as a very delightful experience, except for the vital two minutes and fourteen seconds on the day of the eclipse.

The instruments were as follows:

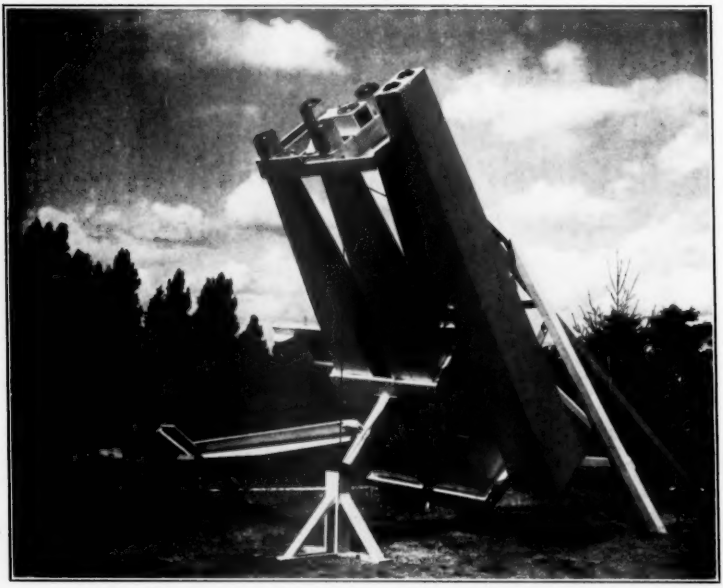
1. The 40-foot telescope. This instrument, for large scale photographs of the corona, was mounted as in previous eclipses, and no further description is necessary. With this instrument ten exposures varying from instantaneous to 32 seconds were to be made on 14x17 inch plates. It was in charge of Mr. Wallace Campbell, assisted by Mr. George M. Day. Mr. Day and his family are the only Americans in Kiev, to the best of his knowledge; he is in charge of the international Y.M.C.A. work in Russia, and we take this opportunity to thank him for the many important ways in which he asssisted us.

2. The Polarizing Photometers. These instruments were the same as those used in the eclipses of 1905 and 1908, with the exception that light tubes and diaphragms were provided in front of the objective ends so as to prevent the entrance of light from any other region than that immediately about the sun. Two of these photometers reflected the light from the corona into the cameras by means of unsilvered glass flats placed at the polarizing angle, and the photometers were mounted at 90° to each other. A third camera was pointed directly to the corona, the aperture of the lens being stopped down to 0.62 inches. The apertures of the others are two inches each, and the focal lengths of all three are very close to fifty inches. These polarigraphs, and the one-prism spectrograph described in the next paragraph, were mounted on the northern polar axis. The axis and its instruments were in charge of Mr. Douglas Campbell, assisted by Mrs. Campbell, Mr. Zenchenko and Mr. Merelli.

PLATE II



THE MOVING PLATE SPECTROGRAPH, THE 40-FOOT TELESCOPE AND OTHER INSTRUMENTS.



VULCANS AND EXTRA-FOCAL PHOTOMETER.
THE LICK OBSERVATORY-CROCKER ECLIPSE EXPEDITION, BROVARY, RUSSIA, AUGUST 21, 1914.

3. The One-Prism Spectrograph. Image lens 1.62 inches aperture and 12.75 inches focal length; collimator lens two inches aperture and 32 inches focus; camera lens 2.06 inches aperture and 12.40 inches focus; and a 60° prism set for minimum deviation at Hγ. Purpose, the photography of the coronal spectrum, and a study of the light distribution in the coronal spectrum.

4. Three-Prism Spectrograph for Accurate Determination of Wave-Length of the Green Coronal Line. Three very dense flint 60° prisms; image lens 2.12 inches aperture and 20.2 inches focus; collimator lens 2.5 inches aperture and 20.96 inches focus; camera lens 2.06 inches aperture and 17.92 inches focus; curved slit with radius of 3.3 inches; total deviation 169° 39′.

5. Objective Grating Spectrograph for study of distribution of the gas in the inner corona which forms the green ring in the spectrum of the corona. Michelson plane grating 15,000 lines to the inch, ruled surface 2.68 by 3.86 inches, used in the second order; a triple camera lens 3.25 inches aperture and 24 inches focus, corrected for the D region of spectrum.

6. Ultra Violet Objective Spectrograph. Single U. V. glass prism, 60°; triple U. V. glass lens 2.60 inches aperture and 78.74 inches focus corrected for wave length 3500. Purpose, to record violet and ultra violet coronal spectrum, and the photometry of the spectrum. The three spectrographs last mentioned were mounted on the southern polar axis, and were in charge of Mr. Charles F. Brush, Jr.

7. Moving Plate Spectrograph for "flash" spectrum. Two 60° prisms giving a deviation at Hγ of 100° 8′; triple camera lens, corrected for Hγ, 2.12 inches aperture and 60 inches focus. The plate holder movement was controlled by a valve regulator on a glycerine clepsydra cylinder, as used in the eclipses of 1905 and 1908. The exposure at this instrument was by Mr. Campbell; it was mounted nearly horizontally in such a position that the tangents to the cusps at second and third contacts would be parallel to the refracting edge of the prisms, and it received its light from a coelostat.

8. The Floyd Telescope, five inches aperture and 70 inches focal length, for smaller-scale photographs of the corona, was mounted horizontally, receiving its light from the same coelostat as the moving-plate spectrograph. The exposures at this instrument were in charge of Mr. Linnik.

9. Four cameras with lenses of three inches aperture and 11 feet 4 inches focal length. These lenses, and the sheet steel tubes in which they were mounted, had been used in previous eclipses in the search for intramercurial planets. While it was the intention to search for such objects on the plates taken with these instruments, this was sec-

ondary to the main purpose. It is an interesting consequence of the theory of relativity that a beam of light passing through a gravitational field should suffer a minute deflection; the total amount of this deflection for a ray from a star passing close to the limb of the sun would be 0″.93 of arc. The doubled effect, for a pair of stars situated on opposite sides of the sun and 20′ distant from the limb, would amount to three-quarters of a second of arc (Cf. articles in the *Publications of the Astronomical Society of the Pacific*, **23**, 219, 272, and **25**, 77). At present this seems to be about the only physical observation which we can make to test the theory of relativity, and naturally it can be made only at the time of total solar eclipse. Professor Einstein, the chief developer of the theory of relativity, has been quite anxious that eclipse observations be made to decide the question of the existence or non-existence of such a deflection of light when passing through a strong gravitational field. While a deflection of the rays from nearby stars, if found, might be complicated with questions as to the amount of refraction caused by the rare matter of the corona, the problem seemed to be of sufficient importance to warrant a thorough trial. The tubes were so arranged that the sun's image fell in the center of each of the four 16 by 20-inch plates used. The axis on which these tubes were mounted was rated for sidereal instead of solar time. Comparison plates of the eclipse region of sky were taken at Mount Hamilton with the instrument set up exactly as it was to be used at the eclipse, and with exposures of the same length as that to be obtained at the eclipse. By measuring the stars found near the sun on the eclipse plates, and comparing their positions with the positions given for the same stars on the comparison plates, any changes due to the action of the sun in bending the rays of light passing near it, could, it is believed, be detected.

As *Regulus* was very favorably placed, slightly over a degree from the eclipsed sun, a fifth lens of the same size and focal length was mounted with the other four, having an ocular provided with cross-wires, and set by calculation so as to have *Regulus* central when the sun's image was central on the large plates; it was hoped to be able to use *Regulus* in this way as a guiding star, to insure perfect roundness in the star images. This mounting was in charge of Mr. Curtis, who was assisted by Mr. Morgilevsky and Mr. Iliinsky.

10. Extra-focal Photometers. These were mounted on the same axis as the four lenses for the relativity test, and consisted of two other lenses of the "Vulcan" type mounted seven inches apart in the end of a double camera tube. The images of the Sun formed by both these lenses fell upon the same 14 by 17-inch plate at the lower end. The lenses (of three inches aperture and eleven feet four inches focal length), were mounted three inches out of focus, and one of the pair was stopped

down so as to give a light reduction of one magnitude. By means of standard squares on the plate and the extra-focal images of the corona and of *Regulus* it was hoped to secure photometric results of considerable value, and data as to the density of the matter forming the corona.

11. A chronograph was mounted and connected with the observing chamber of the 40-foot telescope for recording the times of second and third contacts; it was also connected with automatic contacts on the exposing shutter of the moving-plate spectrograph to record the exposure times with that instrument.

The signals at predetermined intervals before totality, and the counting of the seconds for the observers were given by Kenneth Campbell. General Nicolskoy and his son, with a small telescope for visual observations of the corona and prominences, were also at the camp on eclipse day.

All the plates of the various photometric programs, and selected plates of the 40-foot and Floyd programs, were standardised by the imprinting of photographic squares from an amyl acetate lamp, the principle of equal exposures in equal times at varying distances being followed as far as possible, instead of varying exposures at a fixed distance.

Mr. Wallace Campbell had charge of the meteorological observations at the camp. The geographical coördinates of the camp at Datcha Lavrovskavo are as follows, determined by sextant observations for latitude and time and by transport of our chronometer to the Observatory of Kiev for longitude.

Longitude, $2^h\ 3^m\ 5^s.5$ E. of Greenwich
Latitude $+50°\ 30'\ 24''$

We are indebted to Professor Vogel, Director of the Royal Observatory, Kiev, for the comparison of our chronometer time with accurate Kiev time.

We had not been very long in camp before it became evident that the chances for success on August 21 were very, very slight. To quote from Mr. Wallace Campbell's report on the weather conditions during our stay:

"Of the thirty-five days during which the party was at the station, only ten could be called at all favorable for eclipse observations at 2.47 P.M. (the time of mid-totality), and the conditions on these days were not satisfactory. Not one day of the thirty-five was entirely clear at eclipse time. On average days if a storm was not in the neighborhood the conditions were these: cumulus clouds appeared in a clear sky about ten A.M., and increased steadily to a maximum of about eight tenths between two and three P.M. The cumulus then decreased, disappearing by sunset, and the nights were clear."

Observers at Minsk, Theodosia, and other places on the line of totality report precisely the same state of affairs, and examination of weather records for the past ten years shows that this is the rule in the summer of western Russia. That this fact, so salient and so vital from an eclipse standpoint, namely, that the maximum of day cloudiness came almost precisely at eclipse time, was not noted and communicated to intending observers, seems to have been an inexplicable omission. It is not too much to say that the Lick Expedition would not have been sent had this important fact been known in advance.

Stormy conditions prevailed on the 19th and 29th, and the "tail" of this storm, which so fortunately left clear weather in Sweden and Riga, was just passing at eclipse time on the 21st. Nothing could be seen of the eclipsed sun, and no observations of any sort could be made. Ten minutes later a little might have been secured through a cloud gap, and one hour later the region about the sun was beautifully clear. The temperature fell irregularly for fifteen minutes after the first contact, then uniformly until twelve minutes after the end of totality. The total fall was 2°.6 C. The rate of fall was not noticeably increased during totality. The eclipse was a very dark one for us, probably owing to the thick clouds. Messrs. Jones and Davidson, at Minsk, secured excellent results through a clear space in the generally clouded sky; in the Crimea, Dr. Perrine and Professor Newall were unfortunate enough to strike a cloud between two clear spaces, and secured no results. Several small parties in the Crimea, however, located but a short distance away, had spaces of clear sky about the sun at eclipse time and were successful.

Some ten days after starting life in camp came the order for the Russian mobilization, and we shall always remember the long sad procession of rude carts which passed the Datcha early one morning, transporting the men of our little town to their mobilization depot. The priests, carrying the glittering ikons and banners, gave them their blessing, and the scenes of parting with the wives and children were heart-rending; it was already a tragedy to these peasant women, left behind to gather in their little crops for the winter, and we could but recall that this same tragedy was doubtless at that time being multiplied ten thousand fold by similar scenes in nearly every square mile of Europe. Then came in quick succession those declarations of war which have embroiled Europe in a catastrophe such that the wildest writer of fiction could not have predicted or imagined six months ago. Though Kiev is one of the main mobilization centers, the existence of a state of war did not materially change life in the city, and in our quiet Datcha we experienced only a few minor annoyances, but no serious difficulties. We were impressed with the thorough and business like character of such portions as we saw of the Russian mobilization;

when we left, one month after the declaration of war by Germany, there were still forty great troop trains a day passing through Brovary, and earlier in the mobilization there were more. Communication between Brovary and Kiev became more difficult and uncertain. All gasoline was commandeered, and the never-too-reliable tram was forced to use kerosene instead, while the great Alexander Chain Bridge over the Dnieper was frequently closed for hours at a time for the passage of troops or interminable batteries of heavy artillery. We had intended to bring our Russian volunteer assistants from Kiev to the camp by automobile for the preliminary drills, but all automobiles were taken for military purposes, and according to military proclamation no civilian could even ride in an auto on the streets of Kiev without a permit from the Commandant. "International complications" arose over our jewel of a cook; born in Berlin, she had been so long in Russia that her German speech was not above reproach; able to read and write neither Russian nor German, she did not seem at all dangerous, but no exception could be made to the general order which placed under supervision or detention all German or Austrian subjects. The arrest of this energetic character left such a gap in the internal economy of the camp, that all our influence and that of our Russian friends was at once exerted with the result that after four days she was brought back rejoicing to a welcoming camp. We were treated with great consideration by the officials, and we realize that the small annoyances and troubles we occasionally experienced were due solely to war conditions, and would never have been met with under ordinary circumstances. The German expeditions at Theodosia were not permitted to set up their instruments; the older members of the parties were ordered to leave at once; Doctors Freundlich and Zurhellen of the Berlin Observatory and their mechanician Méchau, being reservists in the German army, were detained, and are believed to be at present in the Volga district as prisoners of war.*

* We are glad to be able to state that this rumor, which reached us while in Russia, is incorrect. According to the November number of *Sirius*, seven of the younger members of the various German expeditions are detained at Odessa; they are reported to be well treated, have the freeeom of the city of Odessa, but must make no change, in abode without permission, and are not treated in any sense as ordinary prisoners of war. We learn from another source that Dr. Pringsheim is at present "detained" in Australia under even more liberal conditions; he has the freedom of the entire continent, and Australian scientists have raised the sum of £450 to keep him in comfort in this rather pleasant exile.

As the German astronomers are reservists, Russia's action in detaining them is, of course, natural. It should be added that the general order for the detention of German and Austrian subjects was not put into effect by Russia until after Russian public opinion had been aroused to a high pitch by stories of insolent and harsh treatment brought back by Russian subjects who had been caught by the war in the various German and Austrian health resorts.

There seemed to be no cause for anxiety as to any hostile action on the part of the simple, kindly Russian peasants, but, that there might be no reason why these should in ignorance be inclined to connect three such events as the eclipse, the American party and the war, brief and sensible proclamations were published by the Governors of Kiev and Chernigov, and by the Metropolitan of the Greek Church in Kiev, explaining the phenomenon. The *ispravnik*, a high official of our District, thought he would do the same, and his proclamation is one of our cherished mementoes of the trip: he advised that the children should be kept indoors and the cattle not be sent out to the fields on the day of the eclipse!

As no civilian freight was being carried by the railroads, the disposal of our instruments became a problem, but this was solved through the kind assistance of General Nicolskoy, who secured special railway transportation from Kiev to the Russian National Observatory at Poulkowa. where Director Backlund is kindly storing the instruments. Whether they are still in storage there, or are being sent to us via Vladivostock and the Pacific, we do not know.

For two weeks before we left the observing station we gave considerable thought to the problem which was always referred to as "getting out." The party had railway tickets, purchased before leaving America, reading through Berlin and Paris, to London, but manifestly no longer of value. The route via Odessa and Constantinople was impossible, as the Russians daily anticipated that Turkey would declare war. A direct rail journey from Kiev to Petrograd, under the war conditions, was very uncertain, and the route via Moscow, Petrograd, and Finland was the only practicable one save that via Siberia. It was feared that the trip would be a long, and perhaps a very trying one. Only one passenger train a day ran from Kiev to Moscow, and neither money nor influence could guarantee a seat on this long, slow and crowded train. As it turned out, this portion of the journey homeward was the only really unpleasant part; from Moscow on, while there was always uncertainty, good accommodations were available. From Moscow we went to Petrograd. Two days were spent there, as the movement of troops in Finland and the taking off of certain trains made it impossible to leave more quickly. It seemed advisable to get to London at the earliest possible moment, partly because of rumors that nearly all Atlantic passenger steamers had been taken off for troop-transport service, but principally because on each section of the journey (except in Sweden and Norway) it was impossible to get reliable information concerning available travel facilities on the next section. It was important to "keep coming." Aside from cloudy sky on August 21, our great disappointments were that we could not take time to visit the Poulkowa Observatory, nor to

see good friends in Stockholm. Professor and Mrs. Backlund and Professor Belopolsky kindly came into Petrograd to see us and assist us. We take pleasure in acknowledging a great many acts of kindness and assistance to the expedition by Professor Backlund. Our acknowledgements are also due to the Russian Imperial Academy of Sciences for many favors.

At Petrograd we were joined for the trip "out" by Messrs. Perrine and Mulvey of Cordoba, who had been at Theodosia, and Messrs. Jones and Davidson of Greenwich, who had been at Minsk. Passing through Finland, we stopped half a day at Tammerfors, a wonderfully clean Finnish manufacturing center; from here we went to Raumo, Finland, where steamer was taken for Stockholm. Twice on this trip passengers were ordered below decks while the steamer threaded passages on the Swedish coast. The youngest member of the party, with American longing for excitement, frequently expressed the hope that we might see a German cruiser, a wish which was not at all echoed by our English colleagues.

After a pleasant day at Christiania, the party went on to Bergen, thence by steamer to Newcastle, England. The life boats were in unostentatious readiness on this trip, but no mine was met with, and the party were very glad to step upon English soil, where everything seemed outwardly to be perfectly normal and going on as usual. Mr. Brush, by a quick trip across England, just managed to catch the steamer on which he had engaged passage, Douglas and Kenneth Campbell, unable to reach Rotterdam for their steamer, had a novel experience of travelling home by steerage. The rest of the party, unable to secure any earlier steamer accomodations than those they had engaged in March, spent two very enjoyable weeks in London, and reached Boston on the 30th of September, glad to be once again in a land where, to quote one of our number, "we are citizens and not subjects."

EUROPEAN ASTRONOMERS.

EDWARD C. PICKERING.

In reply to my request for information regarding European astronomers, letters have been received from Professors Backlund and Schwarzschild. The time of transmission each way was about a month.

Professor Backlund states that "Professor Campbell was at Kiew where it was completely cloudy. His instruments are in Pulkova. At first he intended to go to Riga where I had one of my expeditions. I was glad of this decision because I was strongly convinced that the sky would be favorable in that place, but shortly before the eclipse he changed his mind and went to Kiew. Todd was also in the neighborhood of Kiew. He obtained a couple of poor photographs through the clouds. At Minsk the Greenwich astronomers had chosen a favorable place outside the town and had good luck. In the town itself nothing could be seen. Minsk marks the limit for the clear sky. Our second expedition, fifty kilometers to the southeast was very well equipped for spectral work, but could do nothing. The whole line to Theodosia from Minsk was more or less unfavorable. The expeditions which had located themselves in the town of Theodosia were successful, but those who were a few kilometers outside the town, were unsuccessful. Newall did not see anything; Bjelgowsky had partial success; Donitch (in the town) complete success. I had chosen Riga, in accordance with my opinion that meteorological statistics are not at all reliable for eclipses. I had very fine weather and the astronomer's photographer had very good success. I am convinced that too much work and money are expended on solar eclipses now-a-days. The results are too poor.

"We work as much as the bad times allow. I am very happy to say, that not one of the astronomers has been called to the war. Two French astronomers who observed here were summoned. One of them was the son of the Director of the Paris Observatory, M. J. Baillaud, the other was M. Croze, astrophysicist of the Paris Observatory. Six sons and sons-in-law of Baillaud are in the war. My eldest son is also in the war against the Germans.

"The fundamental observations of 1500 stars for 1915.0 are now almost finished. The corresponding observations at our succursal in Nicolajeff

commenced at the beginning of this year, and will be finished in three years. In Simeis, Bjelgowsky has finished the photographic photometric observations of the polar cap and has now finished the preparation for publication. The visual photometric observations of Kapteyn's areas, so far as they can be observed in Pulkovo are also finished and prepared for publication.

"The comet Encke was found in Simeis, September 20, and was then of the twelfth magnitude, i.e., fainter than was supposed. The luminosity has increased very rapidly, and the comet is now visible to the naked eye. It has a curious kind of tail, a sort of fan in the direction of the daily motion. We have a considerable number of photographs of the comet. It would be most valuable if you had taken some photographs especially for studying the change of luminosity. The magnitude increases more rapidly than the rule $k/r^2\Delta^2$.

"The method of Schlesinger for determining the positions of stars has interested me greatly. It is an excellent enterprise of a high order. If he can organize the re-determination of the zone stars at his observatory, it will mark a considerable progress of methods of observation. I am going to write to him about this. It seems unavoidable that this work should be made in America."

Professor Schwarzschild writes in German and states:—"Of the young astronomers, there are many in the field. Our Dr. Münch is wounded and a prisoner in France. Struve's assistant, Dr. Lippmann, has been killed. Dr. Zurhellen, and Dr. Kühl, who were with the expedition to observe the eclipse of the sun have been retained as prisoners of war in Russia. Among the older astronomers who are not now needed at the front, there are also more soldiers, but they are scarcely in dangerous positions. Bauschinger is a temporary terminus commander in Strassburg. I conduct a military meteorological station in the interest of our aeroplanes and dirigibles here in Namur. For the rest peace and, in a measure, already friendship exists between the population and our soldiers, so much for our 'atrocities in Belgium'."

The references to the war cannot be published. In both cases, they indicate intense patriotism and devotion to their respective countries.

A later letter from Professor Hertzsprung states that Dr. Münch and Dr. Kron received the iron cross, Professor Brendell is retained in France, and it is Dr. Liebmann, not Lippmann, who was killed.

Professor Hertzsprung also gives some remarkably precise results in the measurement of photographs of double stars. It is to be hoped that their publication will not be delayed by the war.

Cambridge Mass.,
Nov. 24, 1914.

THE TAIL OF ENCKE'S COMET.

E. E. BARNARD.

In the December 1914 POPULAR ASTRONOMY I have called attention to some of the peculiarities of Encke's comet at this return. A short tail was shown on the photographs of October 26, but those of October 29 and November 8 did not show any tail.

Moonlight or poor skies prevented any other photographs until November 27, when the comet was picked up close to the horizon in dawn, 3° north west of the planet Mercury. The brightness of the sky would only permit an exposure of eight minutes. I was surprised to find that this short exposure showed a slender straight tail over one degree long, lying in the position angle 298 ½°. The rough position of the comet taken from the BD charts was:

1914 Nov. $27^d\ 23^h\ 37^m$ G.M.T. 1855.0 $\alpha\ 14^h\ 46^m$ $\delta\ -12°\ 10'$.

In the 5-inch guiding telescope the head was small, round and bright, of about the seventh magnitude. I did not notice any tail while guiding.

As shown on the photograph of November 27 the tail does not look like that of October 26, but resembles the slender straight tail sometimes shown on photographs of the ordinary small comet, while that of October 26 is like a thread or chord of sensible and uniform width (2′ wide) attached to the head and slightly curved. The position angle of the tail of October 26 was 324°, while the approximate position of the comet from the photographs was:

1914 Oct. $26^d\ 21^h\ 9^m$ G.M.T. 1855.0 $\alpha\ 11^h\ 24^m$ $\delta\ +51°\ 20'$.

Yerkes Observatory,
Williams Bay, Wis.
1914 December 14.

PLATE III

DELAVAN'S COMET, JULY 24, 1914, 4:00 A. M., MOUNTAIN TIME.

Drawn by Alfred Rordame with a 16-inch Reflector.

OBSERVATIONS WITH A SIXTEEN-INCH REFLECTOR.

ALFRED RORDAME.

I have lately been using a very fine 16-inch Mellish reflector of 100 inches focus. I have tried it with excellent results in astronomical photography. Of course there are only a few nights that the full aper-

SUNSPOT DRAWN BY ALFRED RORDAME JUNE 15, 1914, 5 P.M. MOUNTAIN TIME.

ture can be used in a crowded city like this one. For viewing the sun I use a stop of 12 inches diameter with a first surface reflecting prism and the usual sunshade. The telescope is equatorially mounted with slow motion in both right ascension and declination and thus makes a very fine guiding telescope in connection with a portrait lens camera. As the street lights in this city illuminate the sky to such a degree

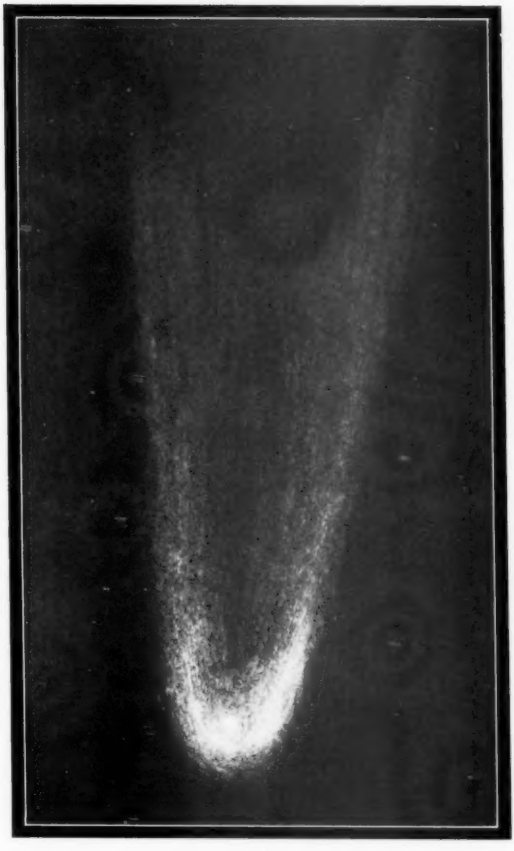
that a long exposure results in fogging the plate, a short exposure only is possible; therefore intensification of the image after development has to be resorted to.

On July 24, Delavan's comet was a hazy patch of light, just visible in a 1½-inch finder. On examination with the 16-inch telescope a bright nucleus was visible, looking like a star shining through a mist, and a wisp of light in the form of a crescent marked the boundary of the

SUNSPOT DRAWN BY ALFRED RORDAME JUNE 17, 1914, 4:30 P.M. MOUNTAIN TIME.

luminous a envelope, having an extension on one side in a direction opposite the sun. On August 19 the comet had become easily visible to the naked eye, and presented a fine view in the telescope. During the remainder of the month of August a number of photographs were taken which all showed the two tails characteristic of this comet.

PLATE IV



DELAVAN'S COMET, AUGUST 19, 1914, 3:30 A. M., MOUNTAIN TIME.

Drawn by Alfred Rordame with a 16-inch Reflector.

PLATE V

DELAVAN'S COMET, SEPT. 18, 1914.

Exposure 4:15 to 4:45 a. m., Mountain Time.
Photographed by Alfred Rordame with a 16-inch Mellish Reflector.
Guiding entirely by hand.

DELAVAN'S COMET, SEPT. 21, 1914.

Exposure 3:45 to 4:45 a. m., Mountain Time.
Photographed by Alfred Rordame with a 2½-inch Portrait Lens.
Guiding entirely by hand.

Cloudy weather prevented an observation of Campbell's comet until October 12, when its light had decreased to 0.17 that at the time of discovery. In the telescope it showed in miniature all the parts of a large comet including nucleus, coma and tail. The group of sunspots that crossed the sun in the middle part of June showed an unusual amount of disturbance and, while the individual spots were not large,

SUNSPOT DRAWN BY ALFRED RORDAME JUNE 19, 1914, 1:45 P.M. MOUNTAIN TIME.

were quite the most interesting I have seen for many years. The detail shown was not all that was visible; the large aperture brings out so much and so many fine granulations, wisps, plumes or whatever names that might be chosen for what is seen, that a complete change of detail is made before they can be drawn. The drawings therefore, while accurate as to detail, do not show the spots all at the same instant like a photograph would show them.

Salt Lake City, Oct. 14, 1914.

AMERICAN ASTRONOMICAL SOCIETY.

REPORT OF THE SEVENTEENTH MEETING.

[*Continued from page 642, Vol. XXII.*]

ON PRESSURE IN THE SOLAR ATMOSPHERE.

By Charles E. St.John.

The preliminary results of an investigation now in progress dealing with the sun-arc displacements of the spectrum lines, show a systematic variation of the displacements with line intensity. For lines belonging to groups a and b the displacements are greatest for the strongest or high level lines. Interpreted as pressure shifts, they show the greatest pressure for the strongest or high-level lines; interpreted as Doppler effects of a downward movement, they show a maximum velocity at the highest level. It then falls to a minimum and rises again, and does the pressure. It appears that over the greater part of the range of intensities, velocity downward is the main effective cause, that this velocity decreases with the depth, and that near the level of lines of solar intensity 4 or 5, a change in conditions takes place, indicating that at this level the pressure begins to act, and that the downward velocity has ceased to be effective.

It appears that above the level of lines of intensity 5, the pressure does not differ greatly from zero. Lines of groups c and d with large positive shifts are displaced to the violet, while lines of group e with large negative pressure shift are enormously displaced to the red. If the pressure is zero at the level of lines of mean intensity 5, these displacements are the results of passing from a pressure of one terrestrial atmosphere to zero pressure, and of the downward velocity in the solar atmosphere. For lines of this mean intensity, the velocities indicated for the five groups of lines are as follows:

Group	a	b	c	d	e
Vel. km/sec	0.47	0.39	0.36	0.53	0.37

The close agreement of the velocities deduced for each group is striking, and appears to find a straightforward interpretation in the hypothesis used.

SPECTROGRAPHIC OBSERVATIONS OF λ TAURI INDICATING THE PRESENCE OF A THIRD BODY IN THE SYSTEM.

By Frank Schlesinger.

During the winter of 1907-8, eighty-one spectrograms of this eclipsing variable were secured at the Allegheny Observatory with a view to determining its orbit. The measurement of these plates revealed the presence of some anomaly, the nature of which could not then be definitely stated. Eight additional plates were secured in 1911-12, and thirty-seven in 1913-14, making one hundred and twenty-six in all. A study of all this material shows that the radial velocity is subject to two periodic variations, the first being synchronous with the well known eclipsing period, a little less than four days; while the second has a period of 34.6 days and a semi-amplitude of about ten kilometers. This latter oscillation is probably due to the presence of a third body whose mass is about two-fifths that of the eclipsing satellite. The system is unique in presenting two periods not commensurate with each other but of the same order of magnitude.

RELATION OF THE PHOTOGRAPHIC AND PHOTOVISUAL MAGNITUDE SCALES.

By Frederick H. Seares.

With the aid of an objective grating Hertzsprung has determined the effective wave-lengths of a large number of stars between magnitudes 9 and 14.5 in N.G.C. 1647. Transformed into color indices, these fix the relation between the photographic and visual magnitude scales for this interval, and afford a control upon the zero points. The mean color index derived from the Mount Wilson photographic and photovisual magnitudes for the interval 11 to 14 agrees with that from the effective wave-lengths within 0.01 magnitude. The indicated uncertainty of the comparison is 0.04 magnitude.

COLOR VARIATION OF THE CLUSTER-TYPE VARIABLE RS BOÖTIS.

By F. H. Seares and Harlow Shapley.

Eighty-five ordinary and isochromatic plates alternately exposed on July 16, 17, and 18, establish with a good degree of precision the photographic and photovisual light curves of the cluster type variable RS Boötis (period $9^h\ 3^m$). The photographic amplitude is 1.5 magnitudes, the photovisual about one magnitude. A clearly marked change in color is thus revealed. The zero points of the magnitude scales are yet to be determined, so that the absolute values of the color index can

not now be given. The change in the color index of 0.4 magnitude agrees satisfactorily with Pease's observations of the change in the spectrum. His limiting values are B8 at maximum and F0 at minimum. The corresponding color indices on Parkhurst's scale would be −0.10 and +0.40. The epochs of maxima for the two curves agree within the uncertainty of the determination.

NEW VARIABLES IN THE CENTER OF MESSIER 3.

By Harlow Shapley.

The intercomparison of several photographs of Messier 3 made at the 80-foot focus of the 60-inch telescope has resulted in the discovery of 23 new variable stars. All but two are less than one minute of arc from the center of the cluster, and are therefore principally in the burned-out portion of the photographs on which Bailey discovered more than 130 variables. (H.A. **78**). A dozen other stars in the center of the cluster are suspected of definite variation, and several suspected by Bailey have been verified. The periods of the new variables are presumably short and their ranges similar to those of objects further from the center, though a number of them, apparently, are considerably fainter at minimum than any magnitude recorded at Harvard.

ON THE NATURE AND CAUSE OF CEPHEID VARIATION.

By Harlow Shapley.

Recent investigations tend to overthrow the theories of Cepheid variation based on the assumption of binary systems. The essential identity of Cepheid and cluster type variables is established by recent work on the spectra, color indices, spectroscopic orbits, periods, and light curves. New arguments against the generally accepted explanation of Cepheids as spectroscopic binaries include:

(1) The Cepheid variables are giant stars, and their volumes are probably fifteen or twenty thousand times the solar volume—a condition which discredits the binary interpretation, both because the average radius of the apparent orbits is only twice the solar radius and because of the very small value of the mass function in every case.

(2) Many cluster type variables are subject to irregularities, not easily reconciled with orbital motion, in the epochs of their most rapid light change, though the mean period remains sensibly constant.

(3) Similarly, successive maxima of certain short period Cepheids oscillate irregularly through a variety of different forms.

(4) The spectra of cluster variables, and probably of Cepheids to a smaller extent, vary continuously during the light period, possibly with discrepancies from maximum to maximum corresponding to the irregularities in the light curves.

As a substitute for the clearly inadequate binary explanation, the writer suggests that recourse be had to interpretations based on the oscillations in the form of isolated stellar bodies. Such periodic disturbances might be set up in various ways, for instance by collisions with smaller masses, and although the ensuing vibration should be perfectly regular in the central mass of the star, it need by no means be so on the radiating surface. The explosive character of cluster variation, the changes in spectral type and other characteristics of the light and spectrum variations might then be the naturally expected consequences of the great temperature and pressure changes and of the probable rupture and scattering of the outer layers of the stellar atmospheres with each pulsation. The velocity variations of Cepheids are always relatively small, and in some conspicuous cases cannot be explained as elliptic motion. Because of their great dimensions, a vibratory change in the radius of only a small fraction of its mean value would give rise to radial motions comparable with those observed. The theoretical possibility of such periodic vibrations in fluid and gaseous bodies has been shown by Kelvin, Ritter, Jeans, Emden, and Moulton. In a gaseous sphere similar in nature to what we might expect to find in the stars, the period of oscillation of a given order depends only on the mean density. Connecting the light changes with the oscillation that is most important and which will persist with undiminished amplitude and period for an extremely long time, the mean density of the star in terms of the Sun is 3.9 divided by the square of the period in hours. For the Cepheids of various spectral types, the densities required by this relation are of the same order as those recently derived for giant eclipsing variables of corresponding spectral class.

SPECTROGRAPHIC OBSERVATIONS OF NEBULAE.

By V. M. Slipher.

During the last two years the spectrographic work at Flagstaff has been devoted largely to nebulae. While the observations were chiefly concerned with the spiral nebulae they also include planetary and extended nebulae and globular star clusters.

Nebular spectra may be broadly divided into two general types (1) bright-line and (2) dark-line. The so-called gaseous nebulae are of the first type; the spiral nebulae of the second type.

Nebulae are faint and hence are generally difficult of spectrographic observation because of the extreme faintness of their dispersed light. In the bright-line spectrum the light is concentrated in a few points; in the dark line (continuous) spectrum it is spread out along its whole length. Hence linear dispersion does not affect directly the brightness of the one but vitally that of the other. Thus while the usual stellar spectrograph may serve in a limited way for the bright-line spectrum it is useless for the dark-line one. This suggests why, until recent years, observations of nebular spectra were devoted chiefly to objects having bright lines. The dark-line spectrum is faint in the extreme. It will not over-emphasize this matter to recall that Keeler in his classical observations of planetary (bright-line) nebulae was able to employ a linear dispersion equal to that given by twenty-four sixty-degree prisms, whereas Huggins was able to obtain only a faint photographic impression of the dark-line spectrum of the greatest of the spirals, the Andromeda nebula.

Unfortunately no choice of telescope—as regards aperture or focal-length or ratio of aperture to focus—will increase the brightness of the spectrum of an extended surface. But the spectrograph greatly influences such a spectrum; and of the spectrograph the camera is the determining factor for brightness. When the one-prism Flagstaff spectrograph used in stellar velocities has its 18.5-inch camera replaced by a 3¼-inch Voigtlander camera it is an efficient instrument for nebular work. This change of cameras increases the speed of the instrument fully 30-fold, while the linear scale of spectrum, in consequence of the powerful prism used, is still one-third that of some instruments now employed elsewhere in stellar velocity work. High angular dispersion is necessary, or at least a good means, for overcoming the photographic difficulty that an absorption line, no matter how dark, can not be recorded by the granular surface of a rapid plate if the line is too fine. In short, there is a limit beyond which it is no longer profitable to narrow the slit. This limit with the Flagstaff spectrograph is rather wide and I have profited by it.

The spectrograph has been attached to the 24-inch refractor and enclosed in a constant temperature case. Seed "30" plates were employed. The comparison spectrum was iron and vanadium.

When entering upon this work it seemed that the chief concern would be with the nebular spectra themselves, but the early discovery that the great Andromeda spiral had the quite exceptional velocity of −300 km showed the means then available, capable of investigating not only the spectra of the spirals but their velocities as well. I have given more attention to velocity since the study of the spectra had been undertaken with marked success by Fath at Lick and Mount Wilson, and by Wolf at Heidelberg.

Spectrograms were obtained of about 40 nebulae and star clusters. The spectrum shown by the spirals thus far observed is predominantly type II (G—K). The best observable nebula, that in Andromeda,* shows a pure stellar type of spectrum, with none of the composite features to be expected in the spectrum of the integrated light of stars of various types and such as are shown by the spectra of the globular star clusters which present a blend of the more salient features of type I and type II spectra.

In the table is a list of the spiral nebulae observed. As far as possible their velocities are given, although in many cases they are only rough provisional values.

N.G.C.	221	Velocity — 300 km	
	224 †	— 300	These nebulae are on the south side of the Milky Way.
	598	—	
	1023	+ 200 roughly	
	1068	+ 1100	
	7331	+ 300 roughly	
	3031	+ small	These are on the north side of the Milky Way
	3115	+ 400 roughly	
	3627	+ 500	
	4565	+ 1000	
	4594	+ 1100	
	4736	+ 200 roughly	
	4826	+ small	
	5194	± small	
	5866	+ 600	

As far as the data go, the average velocity is 400 km. It is positive by about 325 km. It is 400 km on the north side and less than 200 km on the south side of the Milky Way. Before the observation of N.G.C. 1023, 1068, and 7331, which were among the last to be observed, the signs were all negative on one side and all positive on the other, and it then seemed as if the spirals might be drifting across the Milky Way.

N.G.C. 3115, 4565, 4594, and 5866 are spindle nebulae—doubtless spirals seen edge-on. Their average velocity is about 800 km, which is much greater than for the remaining objects and suggests that the spirals move edge forward.

As well as may be inferred, the average velocity of the spirals is about 25 times the average stellar velocity. This great velocity would place these nebulae a long way along the evolutional chain if we undertook to apply the Campbell-Kapteyn discovery of the increase in stellar velocity with "advance" in stellar spectral type.

---

* The bright lines Wolf thought to be present in this and other similar nebulae he has now come to believe were only contrast effects. He also writes that he gets from a recent plate a velocity of —350 km for this nebula.

† Wright at Lick has kindly communicated to me by letter his observation of this object which results in a velocity of —304 km.

N.G.C. 4594, in addition to showing a velocity of 1100 km shows inclined lines. The inclination is about four degrees at wavelength 4300, or four times that shown by a similar spectrogram of Jupiter. Hence the linear velocity of rotation at a distance of 20 seconds from the nucleus of the nebula is eight times Jupiter's limb velocity, or roughly 100 km. The slit was on the long axis of the nebula which makes the axis of rotation perpendicular to the nebula's plane of greatest extension.

ON THE USE OF A THERMO-ELECTRIC PHOTOMETER FOR THE DETERMINATION OF PLATE MAGNITUDES.

By H. T. Stetson.

The possibility of the thermopile as a substitute for the eye in measuring the blackening of a star image on the photographic plate suggested a series of experiments resulting in a form of apparatus to be briefly described.

The instrument consists essentially of a small pin-hole diaphragm strongly illuminated by a constant voltage lamp. An image of the pin-hole is then formed by suitable lenses on the disk of a surface thermopile specially designed by Coblentz. The thermopile is carefully protected from outside disturbance and connected through a resistance box to a D'Arsonval galvanometer of sensitiveness 0.76 microvolts. The plate which is to be measured is placed on a stage directly over the diaphragm and the galvanometer reading noted when the ray of light striking the thermo-element passes through a free space in the background of the plate in the immediate vicinity of a star image. The star image is then moved directly over the pin-hole, the latter always being of a larger diameter than the image, and the fall in the galvanometer reading due to the absorption of the star image carefully recorded.

It has been found from experiment on plates made with the Dearborn Observatory refractor, using Cramer isochromatic plates and color-filter, that a straight line relation holds over a large range between the magnitude of the star and the fourth root of the fall in galvanometer deflection in the form :

$$m = \alpha - \beta \Delta^{1/4}$$

where m denotes magnitude, Δ the difference between the galvanometer reading for the clear plate and the deflection resulting with the interposition of the star image, and α and β are constants of the plate which may at once be determined when the plate includes two stars of known magnitude.

With a single diaphragm the magnitudes of stars ranging from 3 to 8.5 have been measured with an instrumental error not greater than $0^m.02$; and by the use of smaller diaphragms with which the instrument is provided, stars several magnitudes fainter have been measured with about the same order of accuracy. The instrument appears capable of measuring any image which would be black enough for measurement by other methods and has advantages which may be summarized as follows:

1. The thermopile completely replaces the eye in all estimates of size and opacity, thereby eliminating fatigue and personal equation.
2. The reduction formula is of convenient form and involves only the fourth root of Δ, thereby reducing the reading errors four times.
3. The galvanometer deflections are a function of the amount of energy consumed by the reduced silver grains, giving a method of reduction which appears less dependent on the shape of the image than other methods.
4. The instrument has the advantage over other methods of measuring opacity in star disks in that it may be used for plates taken in focus as well as for extra focal images, thereby reducing exposure times, and giving wide range of measurable magnitudes.

THE NEW ALGOL VARIABLE, 10.1914.

By Sidney D. Townley.

The variability of the 7.5 magnitude star B.D. 36° 2344 was announced by W. Ceraski in the *Astronomische Nachrichten* **197**, 256, in March of the present year. The announcement states that twenty-eight photographs of the region of this star were obtained between 1896 and 1913. On twenty-five of these the star was approximately of 7.5 magnitude, while on the other three plates the brightness was from one to one and a half magnitudes less. As stated by Ceraski, this would indicate a variable of the Algol type. The magnitude of this star is given as 8.42 in the Potsdam Photometric Durchmusterung, this result being derived from two concordant observations.

I have obtained observations of this star on twenty-two dates from June 22 to August 19, 1914, and Ceraski's inference that it is a variable of the Algol type is fully confirmed. Decreases in brightness were observed on six dates ranging from July 2 to August 19, and from these a period of 4.795 days has been deduced. The observations are sufficiently numerous to exclude all fractions of this period up to 1/17, which is as far as it was thought necessary to carry the test. The range in brightness is very close to one magnitude. The duration of the eclipse is approximately ten hours. The observations made half

way between minima give no evidence of a secondary minimum, but they are not sufficiently numerous to decide this point with certainty.

The approximate elements, in heliocentric Greenwich mean time, are:

$m = 1914$ July 26 $18^h\ 32^m + 4^d\ 19^h\ 5^m$ E
$= 2420340.77$ D.J. $+ 4.795$ E.

INTENSIFICATION OF OXYGEN AND WATER VAPOR BANDS IN THE MARTIAN SPECTRUM. FROM THE LOWELL OBSERVATORY SPECTROGRAMS OF 1914.

By F. W. Very.

The measures described here rest on four sets of spectrograms by Dr. V. M. Slipher, and have been made possible through the kindness of Dr. Lowell.

By dispensing with a cylindrical lens for broadening the spectrum of Mars, Dr. Slipher has been able to shorten the exposures, thus making it quite certain that none of the variations of intensity in the aqueous band, little *a*, are caused by changes in the humidity of our own atmosphere. As an additional result of this alteration, the spectrograms now record the absorption from different zones of the planet and give, for the first time, information concerning the distribution of aqueous vapor over Martian zones of diverse latitude. The examination of these spectrograms by means of the spectral band comparator and a comparison with results obtained under quite different circumstances in 1909, demonstrates several things, and permits me to announce that, from a comparison of spectra of Mars and the Moon, obtained at nearly equal altitudes and within a few minutes of each other, the apparent greater intensification of little *a* in the Martian spectrum is very much increased when the aqueous contents of the Earth's atmosphere diminish, thus demonstrating that the apparent effect is really that of the Martian atmosphere. Next, it is found that the equatorial regions of Mars are relatively deficient in moisture, but that there is an increment of something like four hundred per cent in the Martian atmospheric moisture in the neighborhood of the melting snow cap, which is thus shown to be the source of the atmospheric aqueous replenishment. Finally, with a higher altitude of Mars, the oxygen interposed by the Earth's atmosphere being less by 0.528 atmosphere, great B, whose Martian intensification (in excess of B's intensity in the lunar spectrum) was 15% in my former measures, had an intensification of 24% in the new measures, proving again that this apparent intensification also is truly Martian, and showing that the actual amount of oxygen in the Martian atmosphere is about half as great as upon the Earth.

(The complete results have been sent to the *Astronomische Nachrichten*, but owing to the dreadful war conditions in Europe it may be a long time before they appear, and I presume the Editor of the *Nachrichten* will have no objection to my making this preliminary announcement.]

THE PERTURBATIONS OF CIRCE.

By D. T. Wilson.

In a paper, The Jupiter-Perturbations of the Asteroids of the Minerva Type, published in Astronomiska Iakttagelser och Undersokninger Band 10, No. 1, the limits of the tables were taken to include all asteroids with a mean daily motion lying between 750″ and 780″. Within these limits the series for the several terms are safely convergent. With a view to enlarging the usefulness of the tables the perturbations of Circe ($n = 805''.2$) were computed and compared with those computed by Hansen's method, *A.N.* 1497. The comparison shows a good agreement except for a few terms. These were made to agree reasonably well by taking two more terms of the series (coefficients were computed but not published in the above paper).

The term (4-7) was found to be divergent for $n = 805''.2$ but convergent for $n = 800''$. This term however is small and can be neglected.

The tables can be used for a mean daily motion of 800″ provided five terms of the series are used.

THE RELATION BETWEEN THE WOLF-RAYET STAR AND THE PLANETARY NEBULAE.

By W. H. Wright.

The paper presents a few general results derived from an investigation of the spectra of the planetary nebula N.G.C. 6572 ($\Sigma 6$), and the Wolf-Rayet star B.D. $+30°3639$. The first object is one of the brightest of the planetary nebulae and contains a fairly condensed nucleus, while the second is the star surrounding which Campbell found an incandescent hydrogen envelope. Since Campbell's discovery the star has been made the subject of investigation by several observers and three nebular lines have been found in its spectrum. The present observations show these and many additional characteristic nebular radiations, to have their origin in the surrounding envelope. N_1 and N_2 are among those present. This array of lines is sufficient to give the envelope the status of a planetary nebula.

The investigation of the nebula Σ6 developes the fact that its nucleus gives a Wolf-Rayet spectrum showing the five characteristic bands λλ 4057, 4633, 4649, 4687, and 5807.

Both of the objects investigated are therefore planetary nebulae with Wolf-Rayet stars for nuclei.

That this is a general rather than an exceptional condition is indicated by the detection by Messrs. Paddock, Merrill and Wright, of Wolf-Rayet bands in the following three planetary nebulae: N.G.C. 6826, N.G.C. Index 418 = S.D.M. − 12° 1172, and N.G.C. 40.

The early contention of Keeler that these two classes of objects are related therefore receives ample confirmation.

Tentative conclusions are drawn as to the nature of some steps in the progression from the nebular to the stellar form. Assuming that there is such a development, it appears probable that the helium settles first, then the material emitting the lines N_1 and N_2, and finally hydrogen.

REPORT OF COMMITTEE

REPORT OF THE CHAIRMAN OF THE COMMITTEE ON PHOTOGRAPHIC ASTROMETRY

By Frank Schlesinger, Chairman.

At the date of this meeting 108 plates have been secured with the four-inch doublet attached to the tube of the Thaw Refractor, and practically all of these have been measured. Only twelve plates remain to complete the equatorial zone, between declinations +2° and −2°. About twenty per cent of the reductions for this catalogue are finished. The meridian observations for the 602 comparison stars were begun in January of this year by Professor Tucker of the Lick Observatory. He expects to complete these observations by the end of this year.

For the reasons stated in the writer's last report no further work has been done on the reductions of the polar trail plates.

A CHINESE STAR MAP TWO CENTURIES OLD.

WILLIAM F. RIGGE.

A Chinese star map two centuries old is indeed a curiosity. It is to be found in the latest volume of the Annals of Zo-Se Observatory, in Zi-Ka-Wei, near Changhai, in China, which was distributed recently. This is for the year 1911, and consists of four parts. The first gives the customary solar observations of the year, the second some visual and photographic observations of double stars, and the third a number of fine photographs of Comet Brooks. The fourth part is the most interesting. It consists of a catalogue of 3083 stars observed during the eighteenth century under the direction of the Jesuit Father Kögler during the reign of the emperor K'ien-Long. The positions of the stars have been reduced to the epoch 1875 by Father Tsutsihashi and compared with European catalogues, especially with Bradley's, so that almost all the stars have been identified.

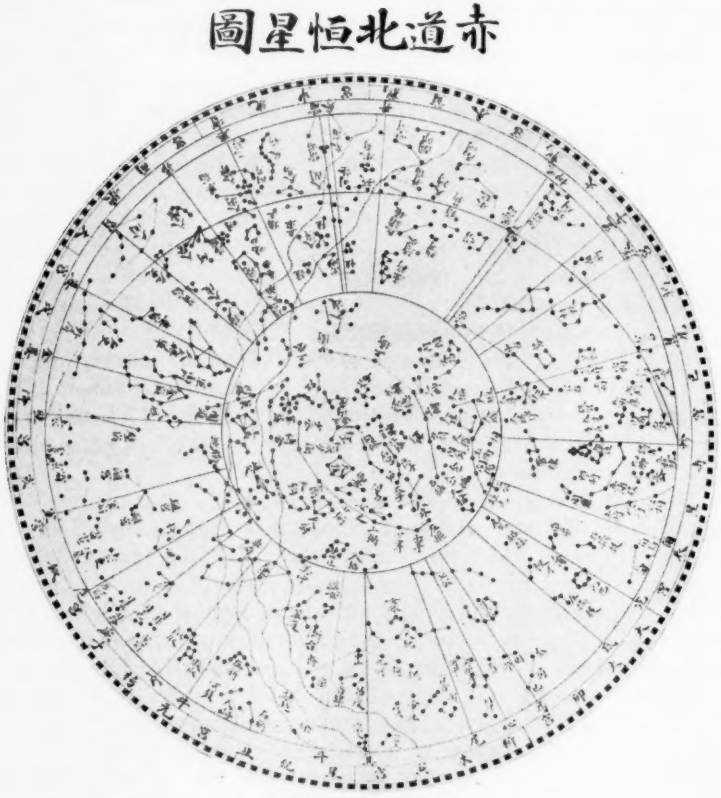
The preface of this catalogue was written by the emperor himself, and is dated the 11th moon of the 21st year of his reign, January 1757. He recalls to memory what his ancestor K'ang-Hi did for astronomy, and what he himself had ordered done to follow the example of his illustrious predecessors.

The first part of this catalogue refers to the construction of an armillary sphere, larger and more perfect than that of Nan Hoai-Jen (Father Verbiest), which was carried off by the Great European Powers during the Boxer trouble in China a few years ago.

The second part deals with the present catalogue of stars. It begins with the list of the personnel of the observatory. After the names of three presidents, of whom the first was Yun Lou, Prince Tchoang, and of two vice-presidents, there follow those of three astronomers, T'ai Tsin-Hien, former president of the astronomical tribunal, raised to the dignity of sub-president of the tribunal of rites, Lieou Song-Lin, president of the astronomical tribunal, and Pao Yeou-Koan, sub-president of the astronomical tribunal. These three were the Jesuit Fathers: Ignatius Kögler, a German, who was born in 1680, arrived in China in 1716, and died March 30, 1746; Augustin von Hallerstein, an Austrian, who was born in 1703, arrived in China in 1738, and died October 27, 1774; and Antony Gogeisl, a Bavarian, who was born in 1701, arrived in China in 1738, and died October 12, 1771. These are followed by nine computers, five students, one draughtsman,

and three other students. To these was added later the name of a fourth Jesuit, Fou Tso-Lin, Felix de Rocha, a Portuguese, who was born in 1728, arrived in China in 1747, and died May 22, 1781.

The complete work contains in reality five catalogues. But the one reproduced in the Annals of the Zo-Se Observatory is the second of these, and is the one giving the stars in the order of their right ascension. It contains the positions of 3083 stars, as said, distributed into

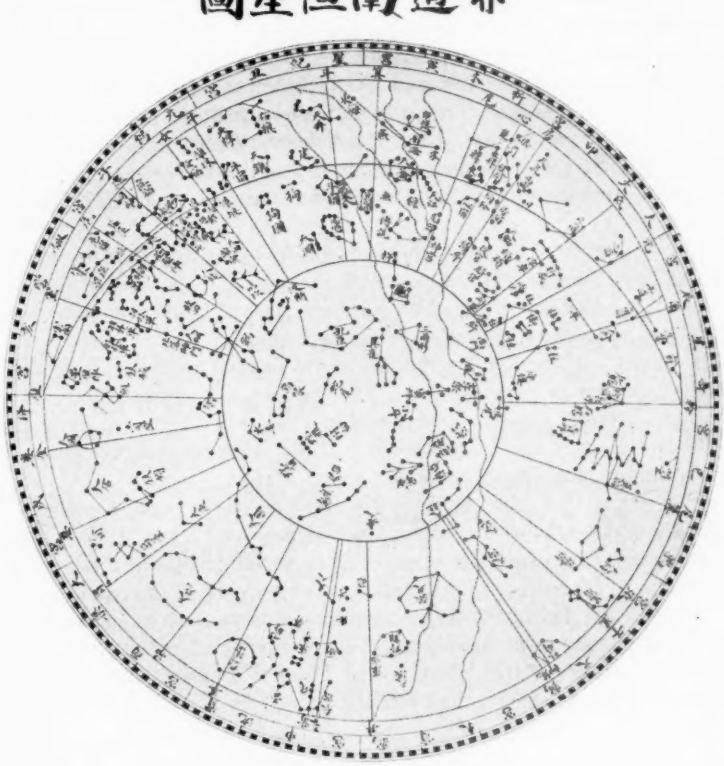


NORTHERN HEMISPHERE.

300 constellations, 23 of which with their 150 stars are near the south pole and invisible in China, their positions having been taken from European catalogues in order to present the celestial sphere in its entirety.

The data of the catalogue are given in ten columns. The first shows the number proper to the catalogue. The second gives the Chinese desig-

nation or name of the star in Chinese and European characters, The third column gives the magnitude to the nearest whole number, the fourth and sixth the right ascension and declination in 1744 in degrees, minutes and seconds, the fifth and seventh the precession expressed in seconds and thirds, that is, sixtieths of a second, just as seconds are sixtieths of a minute. The eighth column shows the right ascension in 1875 in hours, minutes and tenths of a minute, the ninth the declin-



SOUTHERN HEMISPHERE.

ation in degrees, minutes and tenths, and the tenth and last the European name of the star. This catalogue is accompanied by a large number of pages of explanatory matter in Chinese and French.

While this list of stars and their positions is of great value to the professional astronomer, the non-professional will take more interest in the charts. Two circular charts giving the northern and southern

hemispheres on a polar projection, are exclusively Chinese, not only in the Chinese characters denoting the names of the stars and of the constellations, but also in the rather peculiar representation of the stars by dots all of the same size with an utter disregard for magnitude, so that it is not an easy task to trace our familiar groupings in their strange configurations, rendered more embarassing still by the unusual lines connecting the stars. The Big Dipper is the first to be made out after a little study, because the connecting lines are according to our ideas. The Pointers then direct us to the Pole Star which only for this clue would be totally unrecognizable on account of its companions and its greater distance from the pole. Orion is the only other familiar constellation. For the rest of the stars, even the brightest, and their constellations, there is absolutely nothing but their position to serve as an identification mark, and even this is very difficult on account of the magnitude of the precession that has shifted our reference lines during the 170 years that have elapsed since the construction of this Chinese chart.

All the difficulties just mentioned are done away with by Father Tsutsihashi's maps, which have been drawn for the epoch 1875 and presented in modern dress. The stars are marked by dots proportionate to their magnitudes, and are aligned according to our modern ideas. The bounding lines of our familiar constellations are drawn, and their names printed in common type. The stars are also lettered according to our present usage. In addition and without undue crowding, the Chinese names of the constellations and the principal stars are given in both Chinese and European script.

Four charts of this kind are given. Two are on a polar projection and show the stars within 45 degrees of either pole. The other two are rectangular, each extending over 12 hours or 180 degrees in right ascension, and to 50 degrees in declination on either side of the equator.

Besides the invaluable help that this catalogue with its charts gives to Chinese students of astronomy, it is an interesting monument to the scientific activity of the Jesuits in the Chinese Empire two centuries ago, as well as to that of their modern successors.

HOW TO FIND THE CONSTELLATIONS.

MARY H. DUNOVANT, SARAH L. MAYES AND SARAH W. WEINGES.

[*Continued from page 648, Vol. XXII.*]

Canis Minor.

The principal star in the constellation Canis Minor is the brilliantly beautiful star Procyon lying a little west of Regulus which is in the Sickle. Procyon represents the heart of the dog, and another bright star very near it lies in his jeweled collar. A small star marks the waving plume of his tail, while another is in his hind foot. With the exception of Procyon this is a small inconspicuous constellation.

The mythology of Canis Minor is not very interesting; it is too vague and confused. According to legend he represents four different dogs. He is said to be one of Diana's hunting dogs, one of Orion's hounds, one of the dogs that devoured their master Actaeon after Diana had turned him into a stag; and he is supposed to be the dog-headed god Anubis of Egypt.

Cancer (The Crab.)

Cancer is a small constellation containing few bright stars. It is supposed to represent a crab, but the outline is very imperfect. Its most striking feature is a beautiful cluster of stars lying in a westerly direction from Regulus, distant from it twice the length of the Sickle. This group is known as Praesepe, the Bee-Hive or the Manger, the two stars on each side of it representing two colts feeding from the manger. Galileo counted thirty-six of these stars.

Serviss in "Stars with an Opera Glass" tells us that in olden times the Manger was used as a weather-sign. Aratus in his "Diosemia" tells his readers to

> "——watch the manger: like a little mist
> Far north in Cancer's territory it floats.
> Its confines are two faintly glimmering stars;
> These are two asses that a manger parts,
> Which suddenly, when all the sky is clear,
> Sometimes quite vanishes, and the two stars
> Seem to have closer moved their sundered orbs.
> No feeble tempest then will soak the leas;
> A murky manger with both stars
> Shining unaltered is a sign of rain."

Hydra (The Water Snake.)

Below the manger and a little south of it, is a group of four or five stars. This is the head of Hydra, the Water Snake. From its head a curving line of stars sweeps south and east of Leo in a long wavering line, finally reaching the eastern horizon. Hydra is a very long constellation; it sweeps over almost one quarter of the entire circle of the

sky. The only bright star in it is called the heart of the serpent and lies a little south west of Regulus.

On Hydra's back are found Crater, the Cup and Corvus, the Crow.

Crater (The Cup) and Corvus (The Crow.)

Southeast of Leo about twice the length of the Sickle is found the constellation Crater, the Cup, resting on the back of Hydra. By observing closely a curving line of not very bright stars may be seen somewhat resembling a cup in shape. Just east of one handle of the cup is a group of five bright stars representing Corvus, The Crow, four forming a four-sided figure and the fifth just outside. The Crow is just alighting on the back of Hydra. Two of these stars represent his upstretched wings and a third is in the thigh, while the fourth and fifth represent his head and eyes. The constellation bears no resemblance whatever to a Crow, and may be taken as easily for one thing as another. A very interesting legend is told concerning Corvus. It was supposed to be the daughter of the King of Phocis, who in order to escape the pursuit of Neptune was transformed into a Crow.

These constellations are rather bright and conspicuous and may be found with little difficulty.

Leo (The Lion.)

The north star is found by running a line through the pointers five times the distance between them. If a line is drawn through the other two stars of the Great Dipper backwards and upwards, it will pass near a group of bright stars in the form of a Sickle, which forms the head and shoulders of the Lion. The very brightest star in the handle of the Sickle is called Regulus. To the east of the Sickle about ten degrees will be found a group of stars, marking the hind leg and hind quarters of the Lion, while the brilliant star Denebah is found in the end of the tail. Denebah is almost as bright as Regulus.

Leo is standing as if about to spring upon his prey. He faces the west and the star Regulus is in his heart. The sickle shaped figure is in his heart and head. His hind legs extend in a downward direction as if in the act of springing.

The Arabs said that a part of the stars of this constellation formed a Lion and the others the "Kennel Corner", with dogs barking at the Lion. This part of the sky was known as the retreat of the "howling dog". This constellation was known to ancient India and Egypt. In Hebrew mythology it was known as the "Lion of Judah".

The ancients were very superstitious about Leo, because they believed he had great influence upon the weather. The sun is in this constellation during the hottest part of the summer.

Coma Berenices (Berenice's Hair.)

Coma Berenices or Berenice's Hair is a small cluster of stars just east of Leo. This small cluster of stars is interesting mainly because of its beauty. Twenty or thirty of the stars forming the cluster can be easily counted.

The constellation has a very romantic history. The young queen Berenice vowed when her husband went off to war to sacrifice her beautiful hair to Venus if he returned victorious. Her husband returned home victorious and Berenice true to her vow cut off her hair. She carried her hair to the temple of Venus and the same night it disappeared. The guardians of the temple were about to be punished by the king and queen when an astronomer named Conon showed the king and queen the missing locks shining in the sky. He told them that Venus had placed Berenice's beautiful hair among the stars and as they were not skilled in celestial lore they accepted the words of the astronomer and declared that the silvery swarm they saw near Arcturus had never been seen there before.

Virgo (The Virgin.)

In a south easterly direction from Regulus will be found a beautiful, bright, white star forming an isoscles triangle with Regulus and Arcturus. This is Spica which marks a sheaf of wheat which the Virgin holds in her left hand.

Virgo is a long constellation, the stars of which roughly outline a human figure, the Virgin; her head lies toward Regulus, while her feet are marked by two stars just south of Arcturus. Four stars mark her head, three her shoulder and one her extended right hand, while the others form her drapery.

Mythology tells us that long, long ago, the Virgin lived on earth. She was known here as justice. In the golden age she was obeyed by all men, but in the silver age she did not visit the earth so often, "no longer finding the spirit of former days." And during the bronze age when warfare was so common,

> "Justice, loathing that race of men,
> Winged her flight to heaven; and fixed
> Her station in that region
> Where still by night is seen
> The Virgin goddess near to bright Boötes."

Libra (or The Scales.)

Libra or the scales is a small constellation lying between Virgo and Scorpio. The stars form a four sided figure which is not hard to find. The two chief stars lie east of Spica and are about 10° apart. The upper one of these two stars has a singular greenish tint, and the lower one is a double star. These are the only two bright stars in the constellation. Libra represents a balance and is a very old constellation.

Scorpio and Sagittarius.

Just southeast of Libra lies the striking constellation of Scorpio, one of the most beautiful in the heavens. A curved line of bright stars marks the head and claws of the Scorpion and a bright blood-red star, Antares, lies in his heart. Antares gains in redness when viewed closely. This great, red star in size exceeds our sun but it is thought to be almost extinct. From Antares sweeps a glittering curve of stars downward and eastward ending in the Milky Way. These stars mark the body and tail of the Scorpion. The upraised sting in the tail is marked by a bright pair of twin stars, and looks as if it were ready to strike.

Scorpio is one of the few constellations that bears a resemblance to the object that it is named after. It does not require a very strong imagination to see in this long, winding trail of stars a large scorpion.

The Scorpion is trying to get out of the way of Sagittarius, the Archer, who stands east of Scorpio. The Archer holds a bow in his hand with an arrow drawn to its head aimed at the heart of Scorpio. The most conspicuous figure in the constellation Sagittarius is a little milk dipper. This Milk Dipper is outlined by five stars, the handle being straight and the dipper is turned upside down. It is referred to as the Milk Dipper because it is in the Milky Way. The star in the end of the handle of the dipper is placed in the bow of Sagittarius, just within the Milky Way. Above the Milk Dipper is a little group of stars marking the head of the Archer. Three other stars mark the Archer's right arm but the rest of the constellation is rather faint.

Ophiuchus and Serpens.

Ophiuchus lies between Hercules on the north and Scorpio on the south and is too indistinct to be defined accurately. Ophiuchus is called the serpent-bearer because he holds the serpent in both hands. His head is next to the head of Hercules and his left foot rests on the head of the Scorpion. The Serpent's head lies just south of the Northern Crown being marked by a group of four stars. Farther down very close together are found two bright stars marking the fold of the Serpent held in the left hand of Ophiuchus. Somewhat east of these, two other stars mark a corresponding fold held in his right hand.

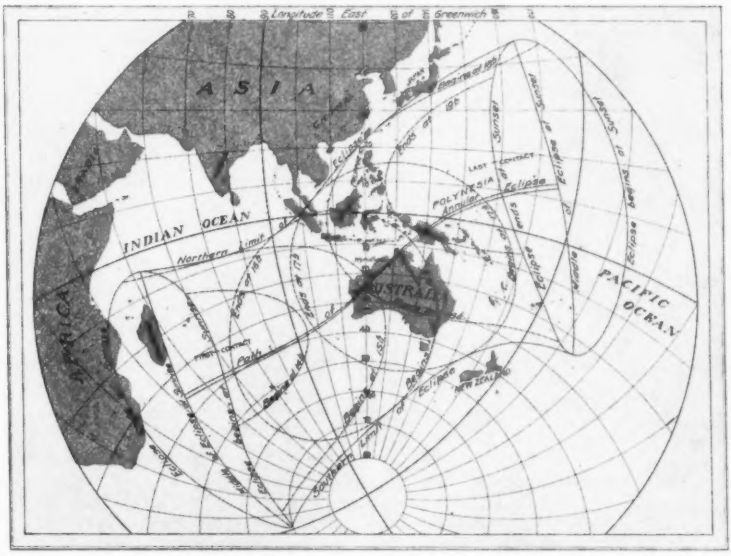
Many interesting names have been assigned to this constellation by the ancients. From the olden maps we find Ophiuchus represented as clutching a writhing serpent with both hands. Ophiuchus was considered in the Middle Ages as a symbol of Moses with the brazen serpent. In Greek theology he was considered the great physician, Aesculapius, who was thought to be able to bring the dead to life again. This constellation of Ophiuchus and Serpens is a very ancient one. It is believed to be at least three thousand years old.

ASTRONOMICAL PHENOMENA IN 1915.

ECLIPSES.

In the year 1915 there will be almost a dearth of eclipses. Only two, the minimum number in any year, will occur. These will both be annular eclipses of the sun. The first of these eclipses occurs on February 13, and the second on August 10. Neither of these will have much interest for American observers, because neither will be visible in the United States or Canada. Both are visible in the southern Pacific and Indian Oceans. The second barely becomes visible in a small part of eastern Asia.

ANNULAR ECLIPSE OF FEBRUARY 13, 1915.



Note:—The hours of beginning and ending are expressed in Greenwich Mean Time.

The following data concerning these eclipses are taken from the *American Ephemeris* for 1915.

I.—*An Annular Eclipse of the Sun*, 1915, February 13, invisible at Washington.

ELEMENTS OF THE ECLIPSE.

Greenwich mean time of conjunction in right ascension, February $13^{d}\ 16^{h}\ 22^{m}\ 35.0^{s}$

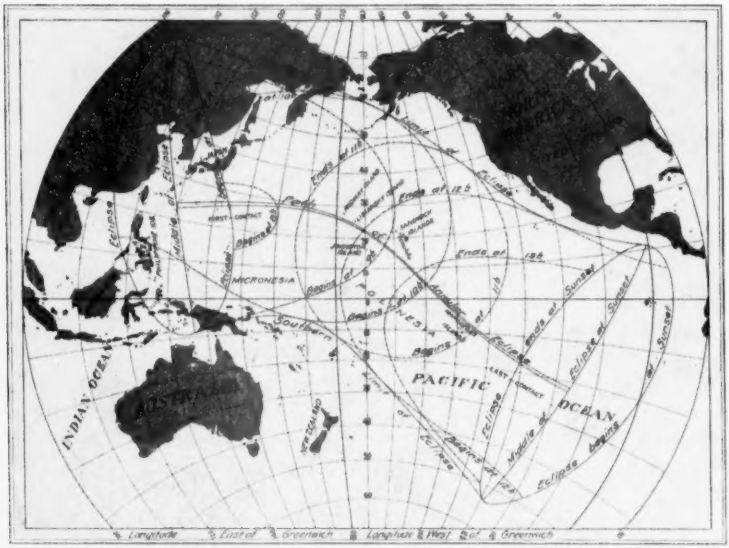
Sun and Moon's R.A.	$21^{h}\ 46^{m}\ 49.92^{s}$	Hourly motions 9.80^{s} and 124.66^{s}	
Sun's declination	$13^{\circ}\ 23'\ 39''.8$ S.	Hourly motion	$0^{\circ}\ 50''.4$ N.
Moon's declination	$13\ 36\ 27''.3$ S.	Hourly motion	$13\ 56''.2$ N.
Sun's equa. hor. parallax	$8''.9$	Sun's true semidiameter	$16\ 11''.7$
Moon's equa. hor. parallax	$57\ 16''.8$	Moon's true semidiameter	$15\ 35''.8$

CIRCUMSTANCES OF THE ECLIPSE.

	Greenwich Mean Time.	Longitude from Greenwich.	Latitude.
	h m s	° ′	° ′
Eclipse begins	Feb. 13 13 41.7	59 40.8 E.	31 45.3 S.
Central eclipse begins	13 14 44.4	42 35.1 E.	35 49.7 S.
Central eclipse at local apparent noon	13 16 22.6	117 57.1 E.	26 29.7 S.
Central eclipse ends	13 18 22.0	174 53.8 E.	13 9.8 N.
Eclipse ends	13 19 24.8	158 9.3 E.	17 17.4 N.

II.—*An Annular Eclipse of the Sun*, 1915, August 10, invisible at Washington.

ANNULAR ECLIPSE OF AUGUST 10, 1915.



Note:—The hours of beginning and ending are expressed in Greenwich Mean Time.

ELEMENTS OF THE ECLIPSE.

Greenwich mean time of conjunction in right ascension, Agust 10 d 10 h 51 m 37.5 s

Sun and Moon's R.A.	9 h 18 m 36.62 s	Hourly motions	9.59 and 122.60 s
Sun's declination	15° 41′ 17.″3 N.	Hourly motion	0′ 43.″7 S.
Moon's declination	15 42 1.1 N.	Hourly motion	12 29.7 S.
Sun's equa. hor. parallax	8.7	Sun's true semidiameter	15 46.8
Moon's equa. hor. parallax	56 10.4	Moon's true semidiameter	15 17.7

CIRCUMSTANCES OF THE ECLIPSE.

	Greenwich Mean Time.	Longitude from Greenwich.	Latitude.
	d h m	° ′	° ′
Eclipse begins	Aug. 10 7 56.1	145 27.3 E.	22 57.5 N.
Central eclipse begins	10 8 59.0	129 39.2 E.	23 12.3 N.
Central eclipse at local apparent noon	10 10 51.6	161 35.0 W.	16 32.4 N.
Central eclipse ends	10 12 45.4	106 31.3 W.	21 55.9 S.
Eclipse ends	10 13 48.2	122 17.9 W.	22 10.7 S.

The regions within which the eclipses of the sun are visible are laid down on the accompanying charts, from which, by means of the dotted lines, the Greenwich mean times of beginning and ending at any place may be found with an uncertainty which will vary from three or four minutes for a high sun to fifteen or twenty minutes when the sun is near the horizon.

THE PLANETS.

The charts, Figs. 1 and 2, as in former years show the courses of the planets through the sky during the year. By the aid of these figures, knowing the constellations, it will be very easy for anyone to identify the planets which are visible to the naked eye, as they change their positions in the sky during the year. They will be useful as well in locating the regions of the sky in which Uranus and Neptune are to be looked for with the telescope. These charts show the positions of the planets at all times of the year. They will of course be invisible at certain times because of nearness to the sun. The charts will make it easy to recognize them again after such periods.

Mercury, because of its small orbit, in general follows the sun as it makes its circuit around the sky. The revolution of Mercury about the sun combined with the motion of the earth causes Mercury to appear sometimes to be moving westward instead of eastward which is its general direction. When it is moving westward in this sense it is said to have retrograde motion. The path of Mercury for the year starts in Sagittarius and moves eastward until February 1, when it begins the formation of a roughly elliptical loop in Aquarius. It completes this loop about the middle of March after which it proceeds eastward again without interruption until the middle of June when it describes another loop in the constellation Gemini. It then moves eastward for the rest of the year, ending its path in the same constellation in which it started, a short distance east of the starting point.

This planet for most of the time is too near the sun to be visible. On and near the following dates, however, it may be seen near the eastern horizon just before sunrise, March 19, July 18, and November 6. On and near the following dates, on the western horizon just after sunset, February 5, May 31, September 27.

Venus will describe a continuous path eastward throughout the year. It will traverse a path one and one-sixth times the circuit of the sky, ending its course four hours to the east of the starting point. It begins the year on the boundary between Libra and Scorpio and ends the year on the boundary between Sagittarius and Capricornus. For a large part of the year Venus will be a brilliantly conspicuous object in the sky. It will be the bright morning star for the first half of the year. It will then move towards the sun and pass on the other side of the sun from the earth about the middle of September. In the latter part of November and in December it will again appear as the evening star.

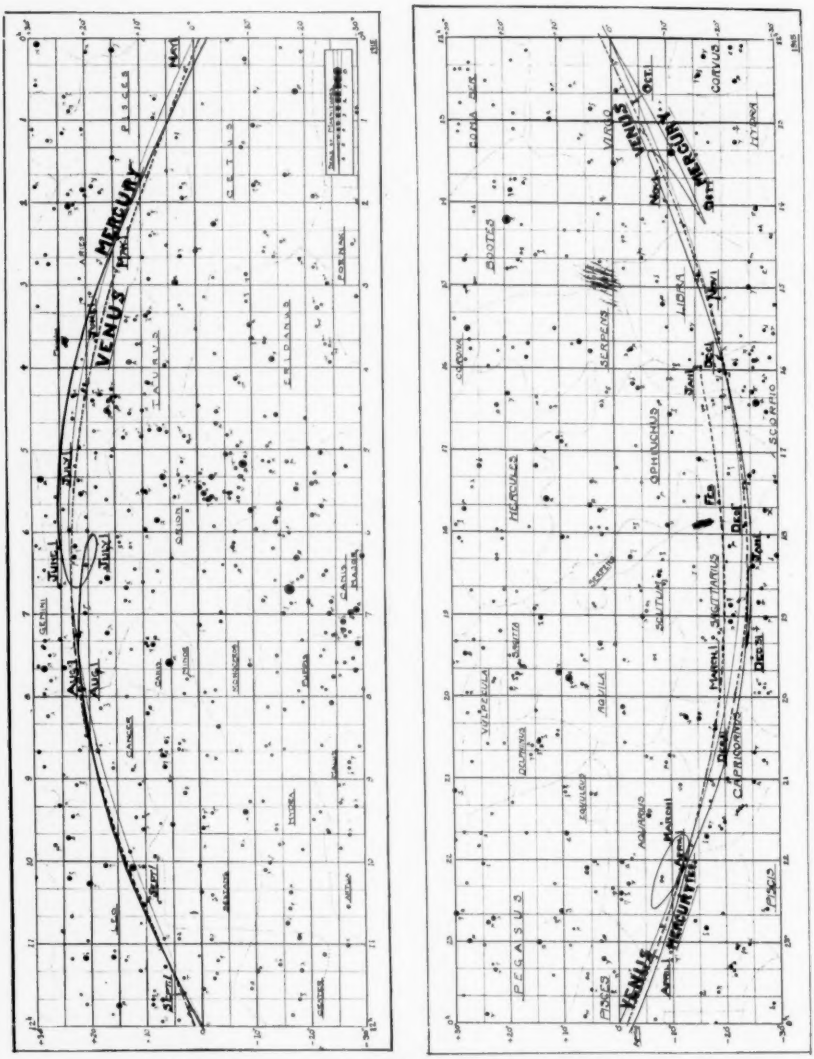


FIG. 1. Apparent paths of the planets Mercury and Venus among the stars during the year 1915.

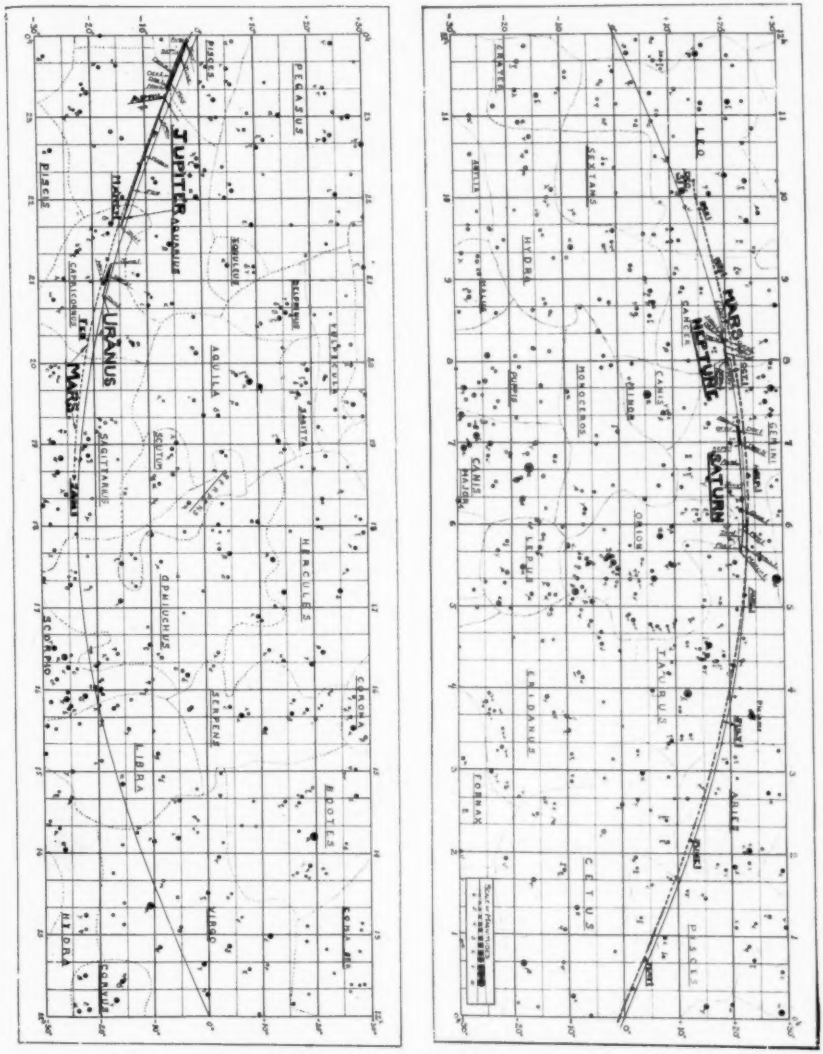


FIG. 2. Apparent paths of the planets Mars, Jupiter, Saturn, Uranus and Neptune among the stars during the year 1915.

Mars, as may be seen from Figure 2, begins the year in the constellation Sagittarius and moves eastward without interruption throughout the year. Its course until July 1 is almost exactly parallel to the ecliptic. It crosses to the north side of the ecliptic in August and remains on that side for the rest of the year. On January 1 Mars will be very near the sun, less than one degree to the west. It will move east a little more slowly than the sun and therefore be visible in the

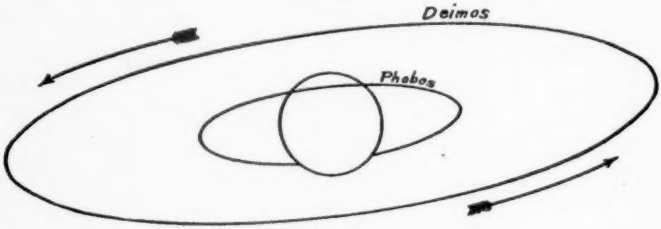


FIG. 3. SATELLITES OF MARS, 1916.
Apparent orbits of the satellites of Mars at date of opposition, February 9, 1916, as seen in an inverting telescope.

morning sky about the first of May. It will be a morning star all year. It will b on the meridian at sunrise on November. Mars therefore does not come to a point of opposition this year. It will be approaching the earth. At the beginning of the year it will be about 225,000,000 miles from the earth and at the end only about 77,000,000. It ends the year in the constellation Leo near the bright star Regulus.

Figure 3 shows the orbits of the satellites of Mars at the date of the next opposition, February 9, 1916.

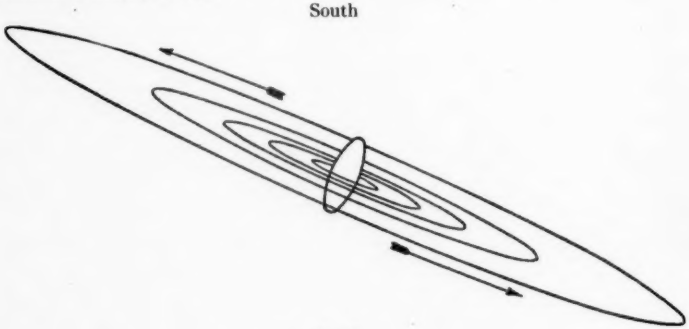


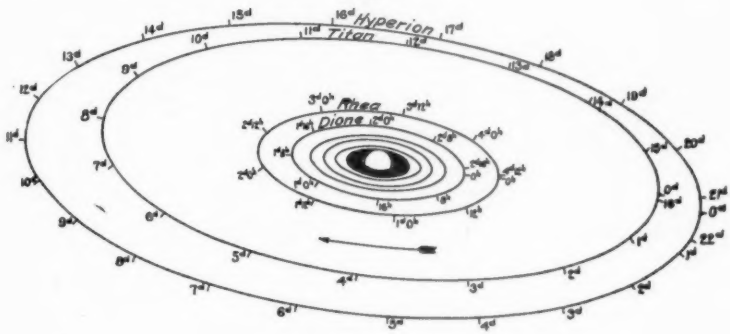
FIG. 4. SATELLITES OF JUPITER, 1915.
FIG. 4. Apparent orbits of five of the satellites of Jupiter at date of opposition, September 16, 1915, as seen in an inverting telescope and elongated in the ratio of three to one in the direction of their minor axes.

Jupiter follows a course from the constellation Capricornus through Aquarius into Pisces from January to July. It then begins a retrograde motion, moving westward until the latter part of November when it turns almost exactly upon its path and ends the year in Pisces. It will begin the year a little to the east of the

sun. In February it will disappear in the rays of the sun and remain invisible until about May 1. In March it will be very near the planet Mars, but unfortunately they will both be lost in the rays of the sun at this time and this interesting phenomenon therefore cannot be seen. It will be on the meridian at midnight in June. From this time on until the end of the year it will be a good object to observe in the evening. It will be at opposition on September 16. Figure 4 shows the apparent orbits of the satellites at this date.

Saturn moves westward for the first two months, then eastward until the latter part of November, then westward again until the end of the year. Its movement is confined entirely within the constellation Gemini. It begins the year in very favorable position for observation, being on the meridian shortly before midnight. It may be observed until about May 1. It will then be low in the west at sunset. During June and July it will be too near the sun to be seen and in August will appear again as a morning star. It will end the year very nearly in opposition. There is no period of opposition within the year 1915. Figure 5 shows the orbit of the satellites of Saturn at the opposition of January 4, 1916.

South



North

FIG. 5. SATELLITES OF SATURN, 1915.

Apparent orbits of the seven inner satellites of Saturn at date of opposition, January 4, 1916, as seen in an inverting telescope.

Uranus describes a short path east then west then east again in the constellation Capricornus during the year. It will be barely visible at all during the first two months. After that time it will then be visible throughout the year, being most favorably situated in the latter part of the summer. The apparent orbits of its satellites at the time of the opposition of August 6 are shown in Figure 6.

Neptune moves back and forth almost exactly on the ecliptic in the constellation Cancer. At the beginning and end of the year it will be well situated. During the summer months it will be too near the sun to be seen. The orbit of its satellite at the time of the opposition of January 19 is shown in Figure 7.

All the figures of this article, except the paths of the planets, are taken from the *American Ephemeris*.

COMETS.

Of the five comets discovered in 1914 the first (Kritzinger) became too faint in the latter part of the summer to be visible; the second (Zlatinsky) also moved south and became very faint so as to be invisible after the early part of the fall; the third (Neujmin) will be very faint at the beginning of 1915, and in the same

part of the sky as the sun, and therefore will probably not be seen at all. It is barely possible that the remaining two, Encke's and Campbell's, may still be seen. Encke's, unfortunately for northern observers, will be very far south, and too faint for any but the largest telescopes. Campbell's will be in the northern sky but also extremely faint. Delavan's comet, discovered the latter part of 1913, the most conspicuous one in 1914, like Encke's will be practically out of reach of the northern observatories. It will however continue to be quite bright for three or four months.

Two of the known periodic comets are due to arrive at perihelion during the year. The first of these, Winnecke, if it arrives according to its period determined at former returns, will be at perihelion about the the middle of September. The earth will be nearest the point of the perihelion of this comet two and a half months before this date.

The second of these, Swift 1889 VI, is due at perihelion on July 7. This comet will be nearest the earth and near a point of opposition a few months after this date.

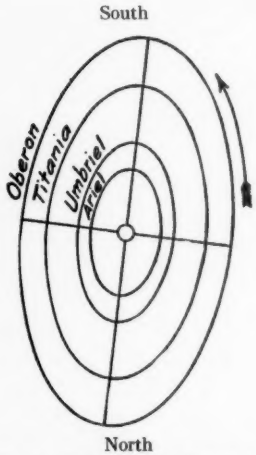


FIG. 6. SATELLITES OF URANUS, 1915. Apparent orbits of the satellites of Uranus at date of opposition, August 6, 1915, as seen in an inverting telescope.

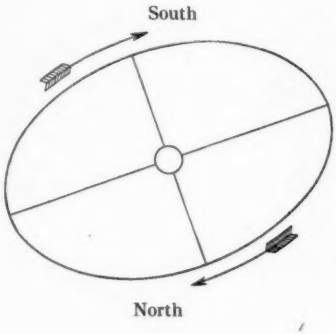


FIG. 7. SATELLITE OF NEPTUNE, 1915. Apparent orbit of the satellite of Neptune at date of opposition, January 19, 1915, as seen in an inverting telescope.

METEORS.

Following is a table showing the dates and the radiant points of the principal meteoric showers during the year. This as in former years is taken from the list published by Mr. W. F. Denning in the *Companion to the Observatory* for 1914. These do not vary from year to year, but are printed here again for convenient reference. The table indicates also the character of the phenomena to be expected in each case. Meteors may be seen at other times also, in fact on any clear night, but at these times they will be more numerous than at others.

Date	Radiant α	Radiant δ	Meteors
	°	°	
Jan. 2-3	230	+53	Swift; long paths.
Apr. 20-22	271	+33	Swift.
May 1-6	338	− 2	Swift; streaks.
July 28-30	339	−11	Slow; long.
Aug. 10-13	46	+57	Swift; streaks.
Oct. 18-20	92	+15	Swift; streaks.
Nov. 14-16	150	+22	Swift; streaks.
Nov. 17-23	25	+43	Very slow; trains.
Dec. 10-12	108	+33	Swift; short.

The Perseids, with maximum on August 11, are visible for a considerable period and their radiant point exhibits a motion to E.N.E. among the stars.

VARIABLE STARS.

The two tables, the one showing times of maxima of 79 short period variables, the other showing times of minima of 109 short period variables, will be continued as formerly through the coming year. These times will be printed one month in advance. They have been computed at the Goodsell Observatory by Miss Hawkes, Miss Wells, Miss Utzinger, and Mr. Hibbard from the latest elements which could be obtained. Some of these elements have been revised since last year. The lists have become so large that space will not permit the printing of more than four dates each month. The period is printed along with these dates so very little calculation is necessary to determine any intermediate maximum or minimum.

OCCULTATIONS.

Those bright stars which are to be occulted by the moon, as shown by the *American Ephemeris*, will be published month by month. This list will be found convenient for those who may possess small telescopes and desire to observe this interesting phenomenon.

PLANET NOTES FOR FEBRUARY, 1915.

The sun will move in a northeasterly direction from the constellation Capricornus into the constellation Aquarius. At the end of the month it will be a little more than eight degrees south of the equator. It will not pass any bright star during this month.

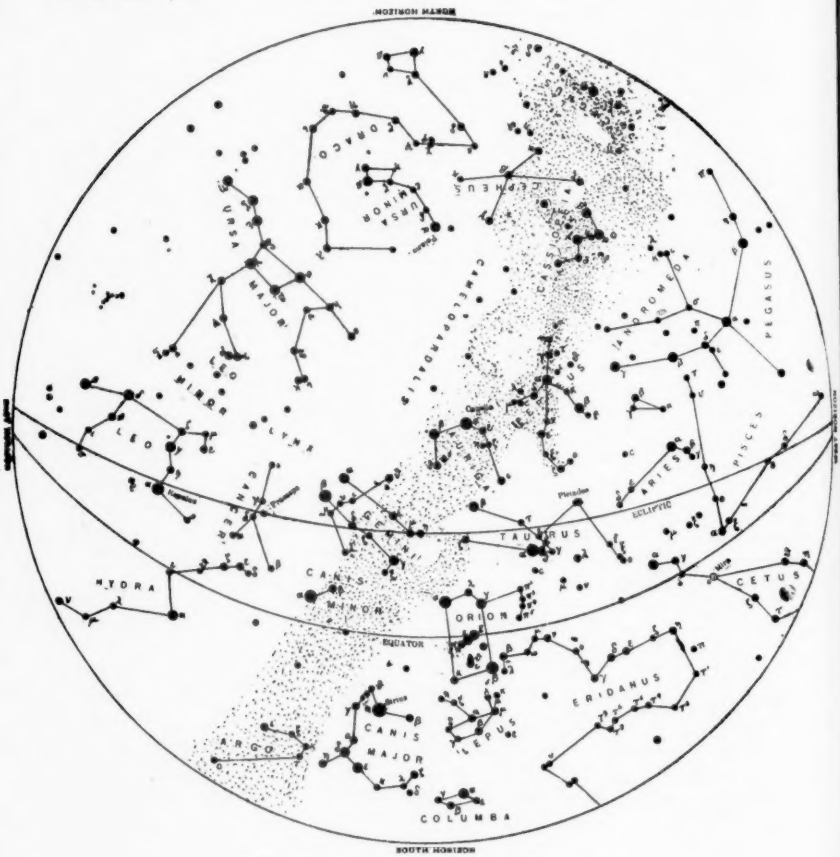
The phases of the moon for this month are as follows:

Last Quarter	Feb.	6	at 11 P.M.	C.S.T.
New Moon		13	" 11 P.M.	"
First Quarter		21	" 9 P.M.	"

Because the preceding month was unusual in that it had two full moons, this month will also be unusual in that it will have none. The next month will again have two.

Mercury will be near a point of greatest elongation east during the first week of the month. At this season it will set about an hour and a half after the sun, and may be seen a little north of the position of the sun just after sunset. It will be rather bright and will be visible even in the twilight. It will swing back rapidly toward the sun and will pass between the earth and the sun on February 21.

Venus will continue to be the bright morning star during this month. It will reach a point of greatest western elongation on February 6. It will also be at nearly its greatest brilliancy at this time. At this season it will rise about three hours before the sun.



THE CONSTELLATIONS AT 9:00 P. M. FEBRUARY 1.

Mars will slowly be moving away from the sun. For several months it will have been too near the sun to be observed and even in this month it will scarcely yet be visible. It will rise only a short time before the sun and still be too near to be studied. It will be approaching the earth.

Jupiter will be still barely visible on the western horizon at sunset, but will soon disappear entirely, being in conjunction with the sun on February 23.

Saturn will be very favorably situated for northern observers. At the beginning of the month it will cross the meridian at nine o'clock. It has a slow retrograde

motion and will consequently come to the meridian earlier on each succeeding night. It will be two and a half times as bright as the first magnitude star Aldebaran which is in the same part of the sky as Saturn.

Uranus will not be visible at the beginning of the month. At the end of the month it may be visible on the eastern horizon just before sunrise.

Neptune will be favorably situated for observation. It will be near the meridian at ten o'clock at night.

Occultations Visible at Washington.

Date 1915	Star's Name	Magnitude	IMMERSION. Washington M.T.	Angle from N.	EMERSION. Washington M.T.	Angle from N.	Duration
			h m	°	h m	°	h m
Feb. 2	79 Leonis	5.5	8 2	113	8 57	353	0 55
2	υ Leonis	4.5	16 30	98	17 32	296	1 2
9	58 G Sagittarii	6.1	17 0	103	18 9	296	1 9
23	136 Tauri	4.6	12 30	76	13 25	252	0 55
25	176 B Gemin.	6.3	8 44	121	10 10	244	1 26
25	181 B Gemin.	6.0	9 29	132	10 50	224	1 21
25	82 Geminorum	6.3	15 5	152	15 47	200	0 42
26	η Cancri	5.5	9 10	164	10 8	247	0 57
26	102 B Cancri	6.5	13 48	105	14 50	258	1 1
26	ϵ Cancri	6.3	13 58	127	15 0	236	1 2

Saturn's Satellites for January 1915.

CENTRAL STANDARD TIME.

E = eastern elongation; W = western elongation;
I = inferior conjunction; S = superior conjunction.

I. Mimas. Period $0^d\ 22^h.6$

		h			h			h			h
Feb.	1	5.6 E	Feb.	7	8.6 W	Feb.	14	10.2 E	Feb.	21	11.8 W
	3	14.1 W		8	7.2 W		15	8.9 E		22	10.4 W
	4	12.7 W		9	5.8 W		16	7.5 E		23	9.1 W
	5	11.3 W		12	13.0 E		17	6.1 E		24	7.7 W
	6	9.9 W		13	11.6 E		20	13.2 W		25	6.3 W

II. Enceladus. Period $1^d\ 8^h.8$

Feb.	1	18.4 E	Feb.	8	14.8 E	Feb.	15	11.3 E	Feb.	22	7.7 E
	3	3.3 E		9	23.7 E		16	20.1 E		23	16.6 E
	4	12.2 E		11	8.6 E		18	5.0 E		25	1.5 E
	5	21.1 E		12	17.5 E		19	13.9 E		26	10.4 E
	7	6.0 E		14	2.4 E		20	22.8 E		27	19.3 E

III. Tethys. Period $1^d\ 21^h.3$

Feb.	2	6.1 E	Feb.	9	19.3 E	Feb.	17	8.5 E	Feb.	24	21.7 E
	4	3.4 E		11	16.6 E		19	5.8 E		26	19.1 E
	6	0.7 E		13	13.9 E		21	3.1 E		28	16.4 E
	7	22.0 E		15	11.2 E		23	0.4 E			

IV. Dione. Period $2^d\ 17^h.7$

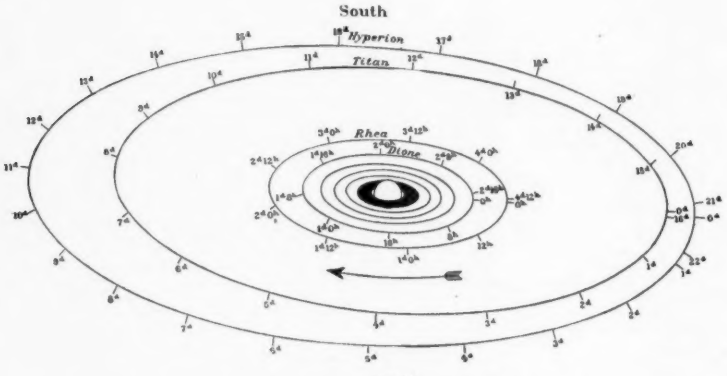
	h		h		h		h
Feb. 2	19.9 E	Feb. 11	0.9 E	Feb. 19	6.0 E	Feb. 24	17.3 E
5	13.6 E	13	18.6 E	21	23.7 E	27	11.1 E
8	7.3 E	16	12.3 E				

V. Rhea. Period $4^d\ 12^h.5$

	h		h		h		h
Feb. 3	2.2 E	Feb. 12	2.9 E	Feb. 21	3.7 E	Feb. 25	16.2 E
7	14.5 E	16	15.3 E				

VI. Titan. Period $15^d\ 23^h.3$

Feb. 3	18.1 E	Feb. 11	14.7 W	Feb. 19	16.3 E	Feb. 27	13.2 W
7	17.7 I	15	14.1 S	23	16.1 I		



Apparent Orbits of the Seven Inner Satellites of Saturn, at date of Opposition, December 20, 1914, as seen in an Inverting Telescope.

VII. Hyperion. Period $21^d\ 7^h.6$

Feb. 1.8 E	Feb. 12.6 W	Feb. 23.0 E	Feb. 27.8 I
6.7 I	18.3 S		

VIII. Japetus. Period $79^d\ 22^h.1$

Feb. 9.3 I	Feb. 28.4 W

IX. Phoebe. Period $580^d\ 2^h.9$

	α Ph.−α Sat.		δ Ph.−δ Sat.			α Ph.−α Sat.		δ Ph.−δ Sat.	
	m	s	′	″		m	s	′	″
Feb. 2	−2	21.1	−3	38	Feb. 18	−2	10.1	−3	54
6	2	18.9	3	44	22	2	6.4	3	55
10	2	16.4	3	49	26	2	2.4	−3	55
14	−2	13.4	−3	52					

VARIABLE STARS.

Approximate Magnitudes of Variable Stars of Long Period on Dec. 1, 1914.

[Communicated by the Director of Harvard College Observatory, Cambridge, Mass.]

Name.	R. A. 1900. h m	Decl. 1900. ° ′	Magn.	Name.	R.A. 1900 h m	Decl. 1900 ° ′	Magn.
S Sculptoris	0 10.3	−32 36	8.9 *i*	T Urs. Maj.	12 31.8	+60 2	8.6 *i*
T Androm.	17.2	+26 26	11.0 *i*	R Virginis	33.4	+ 7 32	6.6
T Cassiop.	17.8	+55 14	8.4	S Urs. Maj.	39.6	+61 38	8.5*d*
R Androm.	18.8	+38 1	12.2*d*	R Can. Ven.	13 44.6	+40 2	10.1 *i*
S Ceti	19.0	− 9 53	9.3 *i*	U Urs. Min.	14 15.1	+67 15	9.8 *i*
Y Cephei	31.3	+79 48	11.4 *i*	S Bootis	19.5	+54 16	8.0
U Cassiop.	40.8	+47 43	11.8 *i*	R Camelop.	25.1	+84 17	8.2
V Androm.	44.6	+35 6	11.5 *i*	V Bootis	25.7	+39 18	9.4 *i*
RR Androm.	45.9	+33 50	9.0	S Cor. Bor.	15 17.3	+31 44	10.6 *i*
RV Cassiop.	47.1	+46 53	9.3 *i*	S Urs. Min.	33.4	+78 58	10.2*d*
W Cassiop.	49.0	+58 1	11.1 *i*	V Cor. Bor.	46.0	+39 52	10.8
Z Ceti	1 1.6	− 2 1	12.6*d*	U Herculis	16 21.4	+19 7	12.0
U Androm.	9.8	+40 11	12.5 *i*	W Herculis	31.7	+37 32	10.1*d*
S Cassiop.	12.3	+72 5	11.6	R Draconis	32.4	+66 58	7.3
S Piscium	12.4	+ 8 24	9.1	S Herculis	47.4	+15 7	11.1*d*
R Piscium	25.5	+ 2 22	7.8	RV Herculis	56.8	+31 22	12.8 *i*
RU Androm.	32.8	+38 10	12.0*d*	T Draconis	17 54.8	+58 14	11.0
X Cassiop.	49.8	+58 46	9.5	RY Herculis	55.4	+19 29	9.9*d*
U Persei	53.0	+54 20	8.2 *i*	T Herculis	18 5.3	+31 0	11.2*d*
R Arietis	2 10.4	+24 35	<11.0	W Draconis	5.4	+65 56	11.7*d*
W Androm.	11.2	+43 50	11.1 *i*	W Lyrae	11.5	+36 38	9.0 *i*
o Ceti	14.3	− 3 26	8.8 *i*	X Ophiuchi	33.6	+ 8 44	7.0*d*
S Persei	15.7	+58 8	10.9 *i*	R Scuti	42.2	− 5 49	5.8
RR Persei	21.7	+50 49	12.6*d*	R Aquilae	19 1.6	+ 8 5	6.6*d*
U Ceti	28.9	−13 35	12.0	RT Aquilae	33.3	+11 30	11.9*d*
R Trianguli	31.0	+33 50	9.1*d*	R Cygni	34.1	+49 58	<12.0
Y Persei	3 20.9	+43 50	8.8 *i*	RT Cygni	40.8	+48 32	9.2*d*
R Persei	23.7	+35 20	13.4	TU Cygni	43.3	+48 49	12.6*d*
V Eridani	59.8	−16 0	9.7	χ Cygni	46.7	+32 40	5.4
RY Tauri	4 15.7	+28 13	10.0	Z Cygni	58.6	+49 46	13.0
W Tauri	22.2	+15 49	10.9	S Aquilae	20 7.0	+15 19	11.5*d*
R Tauri	22.8	+ 9 56	11.2 *i*	Z Aquilae	9.8	− 6 27	9.4 *i*
X Camelop.	32.6	+74 56	13.0	R Delphini	10.1	+ 8 47	11.2
RX Tauri	32.8	+ 8 9	11.7	U Cygni	16.5	+47 35	7.4
R Leporis	55.0	−14 57	8.4	ST Cygni	29.9	+54 38	10.0
R Aurigae	5 9.2	+53 28	10.2 *i*	V Cygni	38.1	+47 47	10.0
W Aurigae	20.1	+36 49	9.7*d*	S Delphini	38.5	+16 44	11.6
T Orionis	30.9	− 5 32	10.3*d*	T Delphini	40.7	+16 2	12.0*d*
SU Tauri	43.2	+19 2	9.1	T Aquarii	44.7	− 5 31	12.7
V Camelop.	49.4	+74 30	12.8*d*	R Vulpeculae	59.9	+23 26	9.4*d*
U Orionis	49.9	+20 10	10.5*d*	TW Cygni	21 1.8	+29 0	12.2*d*
Z Aurigae	53.6	+53 18	10.9	T Cephei	8.2	+68 5	5.6
X Aurigae	6 4.4	+50 15	12.4	S Cephei	36.5	+78 10	8.8 *i*
S Lyncis	35.9	+58 0	13.2*d*	RU Cygni	37.3	+53 52	9.1*d*
R Lyncis	53.0	+55 28	11.9 *i*	RS Pegasi	22 7.4	+14 4	9.0
R Gemin.	7 1.3	+22 52	8.4*d*	S Aquarii	51.8	−20 53	<11.0
R Can. Min.	3.2	+10 11	9.3*d*	R Pegasi	23 1.6	+10 0	7.7
S Can. Min.	27.3	+ 8 32	8.4 *i*	V Cassiop.	7.4	+59 8	12.5
S Gemin.	37.0	+23 41	9.9	W Pegasi	14.8	+25 44	11.6
T Gemin.	43.3	+23 59	8.8 *i*	S Pegasi	15.5	+ 8 22	10.8
R Cancri	8 11.0	+12 2	11.1	ST Androm.	33.8	+35 13	9.6
RT Hydrae	24.7	− 5 59	8.0	R Aquarii	38.6	−15 50	9.4*d*
T Cancri	51.0	+20 14	10.1	R Cassiop.	53.3	+50 50	7.5*d*
W Cancri	9 4.0	+25 39	11.0	SV Androm.	59.2	+39 33	10.9*d*
R Leonis	42.2	+11 54	6.8 *i*				

The letter *i* denotes that the light is increasing; the letter *d*, that the light is decreasing; the sign < that the variable is fainter than the appended magnitude.

The above magnitudes have been compiled at the Harvard College Observatory from observations made by the following observers:—L. Barbour, A. T. Bolfing, T. C. H. Bouton, A. B. Burbeck, H. O. Eaton, F. H. Hay, W Herriott, S. C. Hunter, M. W. Jacobs, Jr., J. B. Lacchini, C. B. Lindsley, O. Mach, C. Y. McAteer, C. S. Mundt, W. T. Olcott, D. B. Pickering, C. Richter, F. H. Spinney, H.M. Swartz, H. W. Vrooman, I. E Woods, and A. S. Young.

Minima of Variable Stars of Short Period.

[Calculated by Elva Utzinger and C. D. Hibbard at Goodsell Observatory.]

Given to the nearest hour in Greenwich mean time; to obtain Eastern Standard time subtract 5h; Central Standard 6h; etc.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1915 February.							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
SY Androm.	0 08.0	+43 09	9.5—13.0	34 21.8			25 4					
RT Sculptor.	31.5	−26 13	9.6—10.5	0 12.3	6 4;	13 21;	21 13					
UU Androm.	38.5	+30 24	10.7—11.9	1 11.7	4 6;	11 16;	19 3;	26 13				
U Cephei	0 53.4	+81 20	7.0— 9.0	2 11.8	5 5;	12 16;	20 4;	27 15				
Z Persei	2 33.7	+41 46	9.4—12	3 01.4	4 6;	10 11;	22 14;	28 17				
TW Cassiop.	37.6	+65 19	8.2— 9.0	1 10.3	4 12;	11 16;	18 19;	25 22				
RY Persei	39.0	+47 43	8.0—10.3	6 20.7	7 15;	14 11;	21 8;	28 5				
RZ Cassiop.	39.9	+69 13	6.9— 8.1	1 04.7	6 12;	13 16;	20 20;	28 0				
TX Cassiop.	44.4	+62 22	9.4—10.1	2 22.2	7 12;	16 7;	25 2					
ST Persei	53.7	+38 47	8.5—10.5	2 15.6	8 10;	16 9;	24 8					
RX Cassiop.	58.8	+67 11	8.6— 9.1	32 07.6		19 19						
Algol	3 01.7	+40 34	2.3— 3.5	2 20.8	3 13;	9 7;	29 18;	26 12				
RT Persei	16.7	+46 12	9.5—11.5	0 20.4	4 2;	10 22;	17 17;	24 12				
λ Tauri	55.1	+12 12	3.3— 4.2	3 22.9	5 8;	13 5;	21 3					
RW Tauri	3 57.8	+27 51	7.1—<11	2 18.5	3 4;	11 11;	19 19;	28 2				
RV Persei	4 04.2	+33 59	9.5—11.0	1 23.4	3 0;	10 21;	18 19;	26 16				
RW Persei	13.3	+42 04	8.8—11.0	15 04.8	3 21;	17 1						
SZ Tauri	31.4	+18 20	7.2— 7.7	3 03.6	2 7;	11 18;	21 5					
RS Cephei	4 48.6	+80 06	9.5—12.0	12 10.1	2 3;	14 13;	27 0					
TT Aurigae	5 02.8	+39 27	7.8— 8.7	0 16.0	2 22;	9 14;	16 6;	22 22				
RY Aurigae	11.5	+38 13	10.7—11.7	2 17.5	4 10;	9 21;	20 18;	26 5				
RZ Aurigae	42.9	+31 40	10.6—13.3	3 00.3	4 4;	10 5;	22 6;	28 6				
SV Tauri	45.8	+28 05	9.4—11.0	2 04.9	9 5;	17 21;	26 13					
Z Orionis	50.2	+13 40	9.7—10.7	5 04.9	4 20;	15 6;	25 16					
SV Gemin.	54.6	+24 28	9.8—<11	4 00.2	8 18;	16 18;	24 18					
RW Gemin.	5 55.4	+23 08	9.5—11.0	2 20.8	5 21;	11 14;	23 2;	28 20				
U Columbae	6 11.2	−33 03	9.2—10.0	2 19.2	5 5;	10 19;	22 0;	27 15				
SX Gemin.	22.0	+20 37	10.8—11.5	1 08.8	8 15;	16 20;	25 0					
RW Monoc.	29.3	+ 8 54	9.0—10.8	1 21.7	3 3;	10 18;	18 9;	26 0				
RX Gemin.	43.6	+33 21	8.8— 9.6	12 05.0		4 18;	16 23					
RU Monoc.	6 49.4	− 7 28	9.8—10.5	0 21.5	4 7;	11 11;	18 16;	25 20				
R Can. Maj.	7 14.9	−16 12	5.8— 6.4	1 03.3	9 0;	18 2;	27 4					
RY Gemin.	21.7	+15 52	8.9—<10	9 07.2	6 18;	16 1;	25 9					
Y Camelop.	27.6	+76 17	9.5—12	3 07.3	1 21;	11 19;	21 17					
TX Gemin.	30.3	+17 8	10.0—11.9	2 19.2	8 5;	16 15;	25 0					
RR Puppis	43.5	−41 08	9.4—10.7	6 10.3	3 12;	9 22;	16 8;	22 19				
V Puppis	7 55.4	−48 58	4.1— 4.8	1 10.9	4 16;	11 23;	19 5;	26 12				
X Carinae	8 29.1	−58 53	7.9— 8.7	0 13.0	5 10;	13 13;	21 16					
S Cancri	8 38.2	+19 24	8.2—10	9 11.6	9 21;	19 9;	28 20					
RX Hydrae	9 0.8	− 7 52	9.1—10.5	2 6.8	6 23;	16 2;	25 5					
S Antliae	27.9	−28 11	6.3— 6.8	0 07.8	2 10;	8 22;	21 21;	28 9				
S Velorum	29.4	−44 46	7.8— 9.3	5 22.4	4 11;	10 9;	22 6;	28 4				
Y Leonis	9 31.1	+26 41	9.3—11.2	1 16.5	4 5;	12 15;	21 1					
RR Velorum	10 17.8	−41 36	10.0—10.9	1 20.5	9 5;	18 11;	27 18					
SS Carinae	10 54.2	−61 23	12.2—12.8	3 07.2	1 23;	8 13;	20 18;	27 9				
ST Urs. Maj.	11 22.4	+45 44	6.7— 7.2	8 19.2	5 14;	14 10;	23 5					

Minima of Variable Stars of Short Period.—Continued.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1915 February.							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	
RW Urs. Maj.	35.4	+52 34	10.3—11.4	7 07.9	4 16;	12 0;	19 8;	26 15				
Z Draconis	11 39.8	+72 49	9.9—13.6	1 08.6	4 8;	11 3;	17 22;	24 17				
RZ Centauri	12 55.6	−64 05	8.5— 8.9	1 21.0	2 14;	10 2;	17 14;	25 2				
SS Centauri	13 07.2	−63 37	8.8—10.4	2 11.5	5 21;	13 7;	20 18;	28 4				
δ Librae	14 55.6	− 8 07	4.8— 6.2	2 07.9	5 7;	12 6;	19 6;	26 6				
U Coronae	15 14.1	+32 01	7.6— 8.7	3 10.9	2 14;	9 12;	16 10;	23 8				
TW Draconis	32.4	+64 14	7.3— 8.9	2 19.4	2 11;	10 21;	19 7;	27 17				
SS Librae	15 43.4	−15 14	9.3—11.5	0 18.4	5 21;	13 13;	21 5;	28 21				
SW Ophiuchi	16 11.1	− 6 44	9.2—10.0	2 10.7	4 20;	12 4;	19 13;	26 21				
SX Ophiuchi	12.6	− 6 25	10.5—11.2	2 01.5	3 19;	12 1;	20 7;	28 13				
R Arae	31.1	−56 48	6.8— 7.9	4 10.2	1 3;	10 0;	18 20;	27 16				
TT Herculis	16 49.9	+17 00	8.9— 9.3	20 18.1	1 7;	10 23;	22 1					
TU Herculis	17 09.8	+30 50	9.5—12	2 06.4	7 8;	14 3;	20 22;	27 17				
U Ophiuchi	11.5	+ 1 19	6.0— 6.7	0 20.1	7 0;	15 10;	23 19					
u Herculis	13.6	+33 12	4.6— 5.4	2 01.2	4 20;	11 0;	17 4;	23 7				
TX Herculis	15.4	+42 00	8.3— 9.0	1 00.7	2 20;	10 1;	17 6;	24 11				
RV Ophiuchi	29.8	+ 7 19	9. —12	3 16.5	6 7;	13 16;	21 1;	28 10				
SZ Herculis	36.0	+33 01	9.5—10.3	0 19.6	3 6;	11 11;	19 15;	27 19				
TX Scorpii	48.6	−34 13	7.5— 8.2	0 22.6	8 10;	15 23;	23 12					
UX Herculis	49.7	+16 57	8.8—10.5	1 13.2	7 6;	15 0;	22 18					
Z Herculis	53.6	+15 09	7.1— 7.9	3 23.8	3 20;	11 20;	19 20;	27 19				
WX Sagittae	53.6	−17 24	9.2—10.8	2 03.1	6 9;	14 21;	23 10					
WY Sagittae	17 54.9	−23 1	9.5—10.6	4 16.0	7 10;	16 18;	26 2					
SX Draconis	18 03.0	+ 58 23	9.3—10.5	5 04.1	4 23;	15 7;	25 16					
RS Sagittarii	11.0	−34 08	5.9— 6.3	2 10.0	1 21;	9 3;	16 9;	23 15				
V Serpentis	11.1	−15 34	9.5—11.1	3 10.9	6 19;	13 17;	20 15;	27 12				
RZ Scuti	21.1	− 9 15	7.4— 8.3	15 03.2	3 5;	18 8						
RZ Draconis	21.8	+58 50	9.5—10.2	0 13.2	4 10;	12 16;	20 23					
RX Herculis	26.0	+12 32	7.0— 7.6	0 21.3	4 16;	13 13;	22 11					
SX Sagittarii	39.7	−30 36	8.7— 9.8	2 01.8	3 2;	11 9;	19 16;	28 0				
RR Draconis	40.8	+62 34	9.3—13	2 19.9	5 9;	13 21;	22 9					
RS Scuti	43.7	−10 21	9.3—10.3	0 15.9	4 2;	10 17;	17 9;	24 10				
β Lyrae	46.4	+33 15	3.4— 4.1	12 21.8		5 5;	18 3					
U Scuti	18 48.9	−12 44	9.1— 9.6	0 22.9	2 13;	12 2;	21 16					
RX Draconis	19 01.1	+58 35	9.3—10.2	1 21.4	4 9;	12 23;	19 13;	27 2				
RV Lyrae	12.5	+32 15	11. —12.8	3 14.4	2 6;	9 11;	16 16;	23 20				
RS Vulpec.	13.4	+22 16	6.9— 8.0	4 11.4	5 17;	14 16;	23 15					
U Sagittae	14.4	+19 26	6.5— 9.0	3 09.1	5 16;	12 11;	19 5;	25 23				
Z Vulpec.	17.5	+25 23	7.3— 8:5	2 10.9	5 1;	12 10;	19 18;	27 3				
TT Lyrae	24.3	+41 30	9.3—11.6	5 05.8	1 4;	6 10;	11 16;	16 22				
UZ Draconis	26.1	+68 44	9.0— 9.8	1 15.1	5 20;	12 8;	18 21;	25 9				
SY Cygni	19 42.7	+32 28	10 —12	6 00.2	1 23;	8 0;	14 0;	20 0				
WW Cygni	20 00.6	+41 18	9.3—13.4	3 07.6	2 6;	8 21;	22 4;	28 19				
SW Cygni	03.8	+46 01	9. —11.7	4 13.8	1 15;	10 19;	19 22					
VW Cygni	11.4	+34 12	9.8—11.8	8 10.3	1 1;	9 12;	17 22;	26 8				
RW Capric.	12.2	−17 59	8.8—10.6	3 09.4	3 10;	10 4;	16 23;	23 18				
UW Cygni	19.6	+42 55	10.5—13	3 10.8	6 14;	13 12;	20 9;	27 7				
V Vulpec.	32.3	+26 15	8.2—9.8	37 19.0		1 12						
W Delphini	33.1	+17 56	9.4—12.1	4 19.4	9 15;	19 6;	28 21					
RR Delphini	38.9	+13 35	10.5—11.8	4 14.4	9 6;	18 11;	27 15					
Y Cygni	48.1	+34 17	7.1— 7.9	1 12.0	5 16;	13 3;	20 15;	28 3				
WZ Cygni	49.3	+38 27	9.9—10.8	0 14.0	6 17;	12 13;	18 10;	24 6				
RR Vulpec.	20 50.5	+27 32	9.6—11.0	5 01.2		10 20;	20 22					
VV Cygni	21 02.3	+45 23	12.1—13.8	1 11.4	5 21;	13 6;	20 15;	28 0				
AE Cygni	09.0	+30 20	10.8—11.4	0 23.3	2 0;	11 17;	21 9					
RY Aquarii	14.8	−11 14	8.8—10.4	1 23.2	6 3;	14 0;	21 21					
UZ Cygni	55.2	+43 52	8.9—11.6	31 07.3	4 6							
RT Lacertae	21 57.4	+43 24	9.1—10.5	5 01.7	1 8;	11 11;	21 15					
RW Lacertae	22 40.6	+49 08	10.2—11.2	5 04.4	5 7;	10 12;	20 21;	26 1				
X Lacertae	22 45.0	+55 54	8.2— 8.6	5 10.6	2 8;	7 18;	18 15;	24 2				
TT Androm.	23 08.7	+45 36	11.3—12.6	2 18.3	4 16;	12 23;	21 5					
Y Piscium	29.3	+ 7 22	9.0—12.0	3 18.4	6 20;	14 9;	21 22					
TW Androm.	23 58.2	+32 17	8.6—11.5	4 02.9	4 15;	12 21;	21 3					

Maxima of Variable Stars of Short Period.

[Calculated by Julia M. Hawkes and Agnes E. Wells at Goodsell Observatory.]

Given to the nearest hour in Greenwich mean time. To obtain Eastern standard time subtract 5h; Central standard time 6h; etc.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1915. February.							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
SX Cassiop.	0 05.5	+54 20	8.6— 9.4	36 13.7			15 20					
SY Cassiop.	0 09.8	+57 52	9.3— 9.9	4 1.7	3 16;	11 19;	19 22;	28 2				
RR Ceti	1 27.0	+ 0 50	8.3— 9.0	0 13.3	6 8;	14 2;	21 20					
RW Cassiop.	1 30.7	+57 15	8.9—11.0	14 19.2		11 12;	26 7					
V Arietis	2 09.6	+11 46	8.3— 9.0	0 23.8	6 22;	14 21;	22 19					
SU Cassiop.	2 43.0	+68 28	6.5— 7.0	1 22.8	5 8;	13 3;	20 22;	28 17				
TU Persei	3 01.8	+52 49	11.4—12.2	0 14.6	1 18;	9 0;	16 7;	23 14				
RW Camelop.	3 46.2	+58 21	8.2— 9.4	16 00.0		16						
SX Persei	4 10.2	+41 27	10.4—11.2	4 07.0	2 3;	10 17;	19 6;	27 20				
SV Persei	42.8	+42 07	8.8— 9.6	11 03.1	6 0;	17 3;	28 6					
RX Aurigae	4 54.5	+39 49	7.2— 8.1	11 15.0		7 4;	18 19					
SX Aurigae	5 04.6	+42 02	8.0— 8.7	1 12.8	4 18;	12 9;	20 1;	27 17				
SY Aurigae	05.5	+42 41	8.4— 9.5	10 03.3		11 0;	21 3					
Y Aurigae	21.5	+42 21	8.6— 9.6	3 20.6	8 16;	16 9;	24 3					
RZ Gemin.	5 56.6	+22 12	9.1—10.0	5 12.7	6 9;	11 22;	22 23;	28 12				
RS Orionis	6 16.5	+14 44	8.2— 8.9	7 13.6	8 1;	15 14;	23 4					
T Monoc.	19.8	+ 7 08	5.7— 6.8	27 00.3		17 13						
RZ Camelop.	23.7	+67 06	11.0—13.0	0 11.5	5 4;	12 9;	19 14;	26 19				
W Gemin.	6 29.2	+15 24	6.7— 7.5	7 22.0	4 6;	12 4;	20 2;	28 0				
ζ Gemin.	6 58.2	+20 43	3.7— 4.3	10 03.7	1 10;	11 14;	21 17					
RU Camelop.	7 10.9	+69 51	8.5— 9.8	22 06.5		8 9						
RR Gemin.	7 15.2	+31 04	10.0—11.5	0 09.5	4 22;	12 21;	20 19;	28 18				
V Carinae	8 26.7	−59 47	7.4— 8.1	6 16.7	1 4;	7 20;	21 6;	27 22				
T Velorum	8 34.4	−47 01	7.6— 8.5	4 15.3	5 4;	14 10;	23 17					
V Velorum	9 19.2	−55 32	7.5— 8.2	4 08.9	8 17;	17 11;	26 5					
Z Leonis	9 46.4	+27 22	7.9— 9.6	59 0.0		10						
RR Leonis	10 02.1	+24 29	9.1—10.1	0 10.9	2 11;	9 6;	16 1;	22 20				
SU Draconis	11 32.2	+67 53	8.9— 9.6	0 15.8	6 20;	13 11;	20 1;	26 16				
S Muscae	12 07.4	−69 36	6.4— 7.3	9 15.8	4 16;	14 8;	24 0					
SW Draconis	12.8	+70 04	8.8— 9.6	0 13.7	6 1;	14 0;	22 0;	29 23				
T Crucis	15.9	−61 44	6.8— 7.6	6 17.6	6 6;	13 0;	19 17;	26 11				
R Crucis	18.1	−61 04	6.8— 7.9	5 19.8	2 21;	8 17;	20 8;	26 4				
S Crucis	12 48.4	−57 53	6.5— 7.6	4 16.6	2 20;	12 6;	21 15;	26 7				
W Virginis	13 20.9	− 2 52	8.7—10.4	17 06.5	3 1;	20 8						
SS Hydrae	25.0	−23 08	7.4— 8.1	8 4.8	6 19;	15 0;	23 5					
RV Urs. Maj.	13 29.4	+54 31	9.2— 9.9	0 11.2	7 9;	14 10;	21 10;	28 11				
ST Virginis	14 22.5	− 0 27	10.3—11.4	0 09.9	3 12;	11 17;	19 22;	28 3				
V Centauri	25.4	−56 27	6.4— 7.8	5 11.9	1 11;	12 27;	23 10;	28 22				
RS Bootis	29.3	+32 11	8.9—10.0	0 09.1	8 9;	15 22;	23 11					
RU Bootis	14 41.5	+23 44	12.8—14.3	0 11.9	5 10;	12 20;	20 6;	27 16				
R Triang. Austr.	15 10.8	−66 08	6.7— 7.4	3 09.3	3 17;	10 12;	17 6;	24 1				
S Triang. Austr.	15 52.2	−63 29	6.4— 7.4	6 07.8	1 20;	8 4;	20 19;	27 3				
S Normae	16 10.6	−57 39	6.6— 7.6	9 18.1		10 15;	20 9					
RW Draconis	33.7	+58 03	9.6—10.8	0 10.6	5 10;	14 7;	23 3					
RV Scorpii	16 51.8	−33 27	6.7— 7.4	6 01.5	1 12;	7 14;	19 17;	25 18				
X Sagittarii	17 41.3	−27 48	4.4— 5.0	7 00.3	2 5;	9 6;	16 6;	23 6				
Y Ophiuchi	47.3	− 6 07	6.1— 6.5	17 02.9		12 19						
W Sagittarii	17 58.6	−29 35	4.3— 5.1	7 14.3	8 7;	15 21;	23 11					
Y Sagittarii	18 15.5	−18 54	5.4— 6.2	5 18.6	3 14;	9 8;	20 22;	26 16				
U Sagittarii	26.0	−19 12	6.5— 7.3	6 17.9	4 5;	10 23;	17 17;	24 11				
Y Scuti	32.6	− 8 27	8.7— 9.2	10 08.3		9 20;	20 4					
Y Lyrae	34.2	+43 52	11.3—12.3	0 12.1	2 19;	8 20;	20 22;	26 22				
RZ Lyrae	39.9	+32 42	9.9—11.2	0 12.3	1 2;	7 6;	19 12;	25 15				

Maxima of Variable Stars of Short Period.—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1915. February.							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
RT Scuti	44.1	−10 30	9.1— 9.7	0 11.9	1 10;	7 9;	19 7;	25 5				
κ Pavonis	18 46.6	−67 22	3.8— 5.2	9 02.2	9 21;	18 23;	28 1					
U Aquilae	19 24.0	− 7 15	6.2— 6.9	7 00.6	1 13;	8 14;	15 14;	22 15				
XZ Cygni	30.4	+56 10	8.6— 9.3	0 11.2	3 8;	10 8;	17 8;	24 8				
U Vulpec.	32.2	+20 07	6.5— 7.6	7 23.5	7 10;	15 9;	23 9					
SU Cygni	40.8	+29 01	6.2— 7.0	3 20.3	3 17;	11 9;	19 2;	26 19				
η Aquilae	47.4	+ 0 45	3.7— 4.5	7 04.2	3 10;	10 15;	17 19;	24 23				
S Sagittae	51.5	+16 22	5.6— 6.4	8 09.2	5 11;	13 21;	22 6					
X Vulpec.	19 53.3	+26 17	9.5—10.5	6 07.7	6 3;	12 10;	18 18;	25 2				
X Cygni	20 39.5	+35 14	6.0— 7.0	16 09.3		17 6						
T Vulpec.	47.2	+27 52	5.5— 6.1	4 10.5	5 6;	14 3;	23 0;	27 10				
WY Cygni	52.3	+30 03	9.6—10.4	0 13.5	7 8;	14 1;	20 19;	27 12				
RV Capric.	55.9	−15 37	9.2—10.1	0 10.7	7 12;	14 5;	20 22;	27 15				
TX Cygni	20 56.4	+42 12	8.5— 9.7	14 17.4	4 0;	18 17						
VY Cygni	21 00.4	+39 34	8.8— 9.5	7 20.6	7 8;	15 5;	23 2					
SW Aquarii	10.2	− 0 20	9.9—10.8	0 11.0	4 19;	11 16;	18 14;	25 11				
VZ Cygni	21 47.7	+42 40	8.2— 9.2	4 20.7	5 11;	10 8;	20 1;	24 22				
Y Lacertae	22 05.2	+50 33	9.1— 9.6	4 07.8	2 2;	10 18;	19 9;	28 1				
δ Cephei	25.5	+57 54	3.7— 4.6	5 08.8	5 22;	11 7;	22 1;	27 10				
Z Lacertae	36.9	+56 18	8.2— 9.0	10 21.1	2 18;	13 15;	24 12					
RR Lacertae	37.5	+55 55	8.5— 9.2	6 10.1	3 19;	10 5;	16 15;	23 1				
V Lacertae	22 44.5	+55 48	8.2— 8.9	4 23.6	4 8;	9 7;	19 7;	24 6				
SW Cassiop.	23 03.7	+58 11	9.2— 9.7	5 10.6	5 15;	11 2;	21 23;	27 10				
RS Cassiop.	32.6	+61 52	9.0—11.0	6 07.1	2 8;	8 15;	21 6;	27 13				
RY Cassiop.	47.2	+58 11	9.3—11.8	12 03.4	7 0;	19 3						
V Cephei	23 51.7	+82 38	6.0— 7.0	0 23.9	3 14;	13 13;	23 13;	28 12				

NOTES FOR OBSERVERS.

Monthly Report of the American Association of Variable Star Observers, Nov.-Dec., 1914.

The favorable fall season for observing is reflected in the following good report. Mr. Richter of Los Angeles, Cal., not content with establishing a record last month of 490 observations, contributes this month 624 estimates. This is a very remarkable performance, and it is doubtful if it has ever been equalled by an amateur engaged in this line of observational work. The climate of California is to some extent responsible for this achievement. Mr. Richter observed on nineteen nights during the month, but only a diligent and zealous observer could accomplish such a result, and his work deserves the highest commendation and praise.

Mr. Maxwell Allen, of the University of California, has kindly consented to coöperate with us in the systematic Novae search we have lately instituted, and will observe zone 13. Mr. McAteer has taken zone 15, Mr. Barbour zone 11, Mr. Putnam zone 5, Mr. Baldwin zone 17, and Mr. Lacchini zones 16 and 23. Sixteen of the twenty-four zones to be observed are now under observation. More volunteers are needed for this work in order that all the zones will be covered. The secretary will be glad to hear from any observers who will undertake to assist in this practical line of work.

VARIABLE STAR OBSERVATIONS NOV.-DEC. 1914.

001032
S Sculptoris

Mo.	Day	Est	Obs.
11	19	9.1	Hy
	20	9.9	R
	20	9.3	Hy
	22	9.5	Hy

001726
T Androm.

Mo.	Day	Est	Obs.
11	2	12.1	Bb
	23	11.3	Y

001755
T Cassiop.

Mo.	Day	Est	Obs.
10	24	8.9	R
	25	9.0	R
	26	8.7	R
11	2	8.7	Bb
	3	9.0	R
	4	7.9	Sp
	4	8.6	S
	4	8.6	R
	4	9.0	M
	5	8.0	Sp
	5	8.7	R
	6	8.2	Bu
	6	8.7	R
	7	8.9	R
	8	9.0	R
	11	8.1	Sp
	12	9.1	R
	13	9.1	R
	14	9.1	R
	15	9.0	R
	16	10.2	R
	17	9.6	R
	18	8.0	Bu
	19	9.4	R
	20	9.7	R
	20	8.6	Bg
	21	8.8	R
	22	8.5	M
	22	8.3	R
	23	8.4	R
	23	8.9	He

001838
R Androm.

Mo.	Day	Est	Obs.
11	17	11.3	Hu
	23	11.8	He

001909
S Ceti

Mo.	Day	Est	Obs.
11	12	9.6	Y
	16	10.2	Pi

003179
Y Cephei

Mo.	Day	Est	Obs.
11	21	11.6	Hu

004047
U Cassiop.

Mo.	Day	Est	Obs.
11	10	12.8	Y
	22	12.0	M
	23	12.1	Y

004435
V Androm.

Mo.	Day	Est.	Obs.
11	2	12.4	Bb
	17	11.9	Hu

004533
RR Androm.

Mo.	Day	Est.	Obs.
11	6	10.0	Bu
	12	9.5	O
	14	9.4	O
	16	9.4	O
	17	9.2	Hu
	18	9.6	Bu
	20	9.4	O
	23	9.4	O
12	4	9.4	O

004746
RV Cassiop.

Mo.	Day	Est.	Obs.
11	2	9.8	Bb
	10	10.3	L
	15	10.5	L

004958
W Cassiop.

Mo.	Day	Est.	Obs.
11	4	11.6	Sp
	5	11.7	Sp
	11	11.6	Sp
	12	11.3	Y
	23	11.5	Y

010102
Z Ceti

Mo.	Day	Est.	Obs.
11	14	11.6	Y
	21	12.4	E
	23	12.1	Y

010940
U Androm.

Mo.	Day	Est.	Obs.
11	20	13.1	E

011272
S Cassiop.

Mo.	Day	Est.	Obs.
11	2	12.6	Bb
	13	12.2	M
10	22	12.0	M

011208
S Piscium

Mo.	Day	Est.	Obs.
11	10	10.0	O
	12	10.4	Y
	16	10.1	O
	21	10.0	E
	23	9.4	Y

012502
R Piscium

Mo.	Day	Est.	Obs.
11	10	7.8	O
	12	8.0	Y
	16	7.6	O
	16	7.8	Pi

013238
RU Androm.

Mo.	Day	Est.	Obs.
11	19	11.7	R

014958
X Cassiop.

Mo.	Day	Est.	Obs.
11	2	10.1	Bb
	6	10.2	Bu
	10	11.3	L
	17	11.2	L
	18	9.8	Bu
	23	9.1	M

015354
U Persei

Mo.	Day	Est.	Obs.
10	11	10.7	He
11	1	9.5	He
	2	9.6	Bb
	3	9.4	Ly
	6	9.0	Bu
	9	9.2	V
	12	9.1	Ly
	13	9.1	He
	14	9.0	Ly
	16	8.7	Pi
	18	8.4	Bu
	19	9.1	V
	23	8.6	M
	27	8.9	He

021024
R Arietis

Mo.	Day	Est.	Obs.
10	24	9.9	R
	25	10.2	R
	26	10.2	R
11	2	10.1	Bb
	2	10.3	Ly
	6	10.7	R
	6	10.4	Bu
	7	11.0	Ly
	7	10.5	Bg

021143
W Androm.

Mo.	Day	Est.	Obs.
11	2	12.5	Bb
	10	11.8	Y

021403
o Ceti

Mo.	Day	Est.	Obs.
10	21	9.0	L
	24	9.0	R
	25	8.9	R
11	2	9.2	Ly
	2	8.5	Bb
	4	8.8	R
	5	8.8	R
	6	9.0	R
	6	8.9	Bu
	7	8.9	R
	9	8.9	Bg
	9	8.9	L
	10	8.9	Ma
11	12	8.8	O
	13	8.9	L
	15	8.9	R
	16	9.0	E
	16	9.0	Pi
	16	8.9	R
	17	8.9	R
	18	9.2	Bu

o Ceti

Mo.	Day	Est.	Obs.
11	19	8.8	R
	20	8.8	Bg
	20	8.9	R
	20	9.0	O
	21	9.0	Hu
	21	8.8	R
	22	8.9	R
	23	8.9	R

021658
S Persei

Mo.	Day	Est.	Obs.
11	2	11.6	Bb
	6	11.5	Sp
	7	11.8	Ly
	12	11.6	Ly
	12	11.5	Sp
	13	11.0	Bg
	16	11.5	Pi
	19	11.2	E
	22	11.3	Bg

022000
R Ceti

Mo.	Day	Est.	Obs.
11	12	12.5	Y

022150
RR Persei

Mo.	Day	Est.	Obs.
11	10	11.9	Y
	23	12.4	Y

022813
U Ceti

Mo.	Day	Est.	Obs.
11	2	10.9	Bb
	20	11.6	Bg

023133
R Triang.

Mo.	Day	Est.	Obs.
11	2	7.8	Bb
	6	8.2	Bu
	10	8.4	O
	16	8.5	O
	16	8.4	B
	18	8.6	Bu
	20	8.9	O
	23	8.6	O
12	4	9.2	O

024356
W Persei

Mo.	Day	Est.	Obs.
10	24	9.4	R
	25	9.4	R
	26	9.4	R
11	1	9.8	He
	2	10.3	Ly
	4	9.6	R
	5	9.2	Hy
	6	9.8	Bu
	6	10.4	R
	6	9.4	Hy
	7	10.4	Ly
	7	10.5	R
	7	9.6	Hy
	8	10.6	R

W Persei

Mo.	Day	Est.	Obs.
11	12	10.3	Ly
	12	10.5	R
	12	10.4	O
	12	9.7	Hy
	13	10.4	Pi
	13	10.6	R
	13	10.3	L
	13	10.0	M
	13	10.2	Bg
	14	10.6	R
	15	10.5	L
	15	10.7	R
	15	10.0	Hy
	16	10.2	Pi
	16	10.4	R
	16	10.3	Ly
	16	10.5	Hy
	19	11.0	Hy
	19	10.8	R
	20	10.2	L
	20	10.6	R
	20	11.0	Hy
	20	9.6	Hu
	21	10.5	R
	22	10.5	R
	22	10.4	Bg
	22	9.8	Hy
	23	10.2	M
	23	10.4	R
	27	10.4	He

030514
U Arietis

Mo.	Day	Est.	Obs.
11	10	13.0	Y
	23	13.0	Y

032043
Y Persei

Mo.	Day	Est.	Obs.
10	24	10.0	R
	25	9.9	R
	26	10.0	R
11	1	9.6	He
	2	10.2	Bb
	2	9.9	Ly
	4	10.1	R
	4	9.8	Ly
	5	9.9	R
	6	10.2	Bu
	6	9.9	R
	7	9.6	Ly
	7	9.7	R
	8	9.5	R
	9	9.0	Ly
	10	9.5	Ma
	12	8.6	Ly
	12	9.6	R
	12	9.3	Hy
	13	9.6	Bg
	13	9.7	R
	14	9.6	R
	15	9.9	R
	15	8.5	Hy

VARIABLE STAR OBSERVATIONS Nov.-Dec., 1914.—Continued.

Y Persei

Mo.	Day	Est	Obs.
11	16	8.6	Ly
	16	9.7	R
	16	8.7	Hy
	17	9.4	O
	17	9.2	Ma
	19	9.6	R
	19	8.5	Hy
	20	9.7	R
	20	8.7	Hu
	20	8.5	Hy
	21	9.8	R
	21	9.2	Ma
	22	8.0	Hy
	22	9.7	R
	22	9.4	Bg
	23	9.3	M
	23	9.7	R

032335
R Persei

11	10	13.2	Y
	20	11.6	Hu

033362
U Camelop.

11	2	7.8	Ly
	6	7.8	Bu
	7	7.9	Ly
	10	7.8	Ma
	12	7.9	Ly
	16	7.8	Ly
	19	8.5	R
	20	8.4	R
	21	7.8	Ma
	21	8.3	R
	22	8.3	R

035915
V Eridani

11	16	9.6	Pi
	22	9.5	Bg

042215
W Tauri

11	2	9.8	Bb
	6	10.1	Ly
	6	10.4	Bu
	9	10.2	M
	11	10.3	Pi
	11	10.2	Ly
	13	10.4	M
	15	10.4	Bg
	16	9.8	B
	16	10.4	Ly
	17	10.4	Lv
	20	10.7	O
	22	10.6	M

042209
R Tauri

11	10	12.0	Y
	12	11.8	M

042309
S Tauri

11	12	11.5	M

043208
RX Tauri

11	12	11.9	M
	27	11.8	B

043274
X Camelop.

11	2	11.6	Bb
	2	11.7	Ly
	11	12.5	Sp

044617
V Tauri

11	16	12.9	B

045514
R Leporis

11	6	7.1	Sp
	10	6.2	Bu
	12	7.2	Sp
	12	8.2	M
	15	7.3	L

050953
R Aurigae

11	2	11.0	Bb
	4	10.5	Sp
	6	11.2	Ly
	11	10.2	Bg
	13	9.6	M
	16	10.5	B
	17	11.1	Pi
	20	10.5	Bg

052034
S Aurigæ

10	21	10.0	L
11	1	9.1	He
	9	9.3	M
	13	9.6	L
	13	9.4	M
	16	8.5	B
	23	9.5	M

052036
W Aurigae

11	1	9.4	He
	9	9.2	M
	13	9.3	M
	23	9.5	M

052405
S Orionis

11	10	10.6	Bu
	12	9.0	M
	27	9.6	M

053005
T Orionis

Mo.	Day	Est.	Obs.
11	12	9.8	M
	13	9.9	M
	17	10.0	M
	17	9.7	Pi
	21	10.1	M
	27	10.2	M
	29	10.3	He

054319
SU Tauri

11	10	9.4	Y

054615
RU Tauri

11	10	12.7	Y

054920
U Orionis

11	2	10.1	Bb
	10	10.6	Bu
	12	10.0	M
	13	9.7	L
	16	10.2	Pi
	17	10.1	M
	20	10.0	Hu
	22	10.2	Bg
	27	10.3	M

054974
V Camelop.

11	11	9.8	Sp
	14	12.0	Y
	23	12.6	Y

055353
Z Aurigae

11	16	10.9	Y
	21	10.8	E
	23	11.0	Y

060450
X Aurigae

11	2	9.7	Bb
	23	12.3	B

060547
SS Aurigae

11	17.5	12.4	E
	18.6	11.9	L
	18.6	11.2	E
	19.5	10.8	E
	19.6	10.7	E
	20.2	10.6	L
	20.6	10.6	E
	21.5	10.5	E
	22.6	10.5	E
	23.4	11.0	Y
	24.6	10.4	E
	27.5	11.4	Y
	28.4	11.5	Y

061647
V Adrigae

11	23	9.0	B

063159
U Lyncis

11	16	13.0	Y

063558
S Lyncis

11	16	13.0	Y

064922
Nova Gemin.

11	2	11.7	Bb
	15	12.0	L
	18	11.9	L

065208
X Monoc.

11	15	9.6	L

065355
R Lyncis

11	23	12.4	Y

070122a
R Gemin.

11	2	7.8	Bb
	11	8.1	Pi
	18	8.6	M
	27	8.3	M

070310
R Can. Min.

11	15	9.0	L
	16	9.1	Pi

072708
S Can. Min.

11	2	9.0	Bb
	4	9.0	Ly
	8	8.9	Ly
	11	9.0	Ly
	12	9.0	M
	14	8.9	Ly
	15	8.8	L
	16	8.8	Pi
	17	8.7	M
	19	8.9	Ly
	19	9.9	Bg
	22	8.6	M
	23	8.7	Ly
	27	8.5	M

073508
U Can. Min.

11	15	10.4	L
	27	9.5	M

073722
S Gemin.

11	18	9.5	M
	27	9.9	M

074323
T Gemin.

11	11	9.5	Pi
	16	9.3	Pi
	18	9.3	M
	27	8.9	M

081112
R Cancri

11	2	9.1	Bb
	12	11.0	M
	18	10.9	M
	18	11.3	L

082405
RT Hydrae

11	2	8.8	Bb
	15	8.4	L

085120
T Cancri

11	2	9.5	Bb
	18	10.1	L

093178
Y Draconis

11	23	12.5	Y

093934
L Leo. Min.

11	18	12.0	M

094211
R Leonis

11	3	8.6	Ly
	8	8.5	Ly
	12	7.8	M
	12	8.5	Ly
	18	8.2	L
	18	7.4	M
	19	7.3	Bg
	28	6.9	M

103012
U Hydrae

11	15	5.4	L
	18	5.0	L

104620
V Hydrae

11	18	6.2	L

123160
T Urs. Maj.

11	12	11.8	M
	14	10.9	Bg
	16	10.0	E
	28	8.9	M

123307
R Virginis

11	18	6.7	L

VARIABLE STAR OBSERVATIONS Nov.-Dec., 1914.—Continued.

123961
S Urs. Maj.

Mo.	Day	Est.	Obs.
11	2	7.7	M
	3	7.9	He
	4	7.6	M
	4	8.0	Ly
	9	7.8	M
	10	8.1	Ly
	12	8.0	M
	14	8.3	Bg
	16	8.4	E
	18	8.1	M
	18	8.1	L
	25	8.3	M
	28	8.4	M

132706
S Virginis

11	18	8.9	L

134440
R Can. Ven.

11	18	10.7	M
	18	10.6	L
	28	10.3	M

141567
U Urs. Min.

11	10	10.0	S
	18	10.1	M

141954
S Boötis

11	4	9.8	Ly
	7	9.7	L
	10	9.4	Ly
	12	9.4	Ly
	15	9.5	L
	18	8.2	M

142539
V Boötis

11	3	9.8	Ly
	9	9.8	L
	9	9.4	Bg
	10	9.7	Ly
	13	9.5	Ly
	15	9.9	L
	18	9.6	M

142584
R Camelop.

11	4	8.6	Ly
	9	8.6	L
	10	8.6	Ly
	10	8.6	O
	12	8.4	O
	13	8.5	Ly
	15	8.4	Ly
	16	8.4	O
	23	8.4	O
	27	8.1	B
	28	8.4	O
12	4	8.4	O

143227
R Boötis

Mo.	Day	Est.	Obs.
10	29	9.6	Ly

151731
S Cor. Bor.

10	31	10.5	He
11	10	11.0	Ly
	13	10.9	Ly

153378
S Urs. Min.

11	6	10.1	Ly
	9	10.0	L
	9	10.5	Bg
	9	9.4	M
	11	10.4	Bg
	13	10.3	L
	13	10.3	Ly
	14	10.3	Ly
	17	10.5	Pi
	18	10.2	M
	20	10.7	Bg
	27	10.0	B

154428
R Cor. Bor.

10	25.6	6.2	R
	26.6	6.1	R
11	2.5	6.0	Ly
	4.4	6.3	M
	4.5	6.0	R
	6.6	6.2	R
	7	6.0	L
	7.4	6.0	Ly
	7.5	6.4	Mu
	8	5.9	Ma
	9.5	6.1	Ly
	9.5	6.7	Bg
	10.5	6.6	Mu
	12	5.9	H
	12.5	6.0	Ly
	14.5	6.0	Ly
	15	6.0	L
	16.5	6.0	Ly
	17.5	6.1	Ly
	18.5	6.0	Ly
	19.5	6.0	Ly
	21.4	6.0	Ly
	23.5	6.1	Ly
	24.4	6.1	Ly

154539
V Cor. Bor.

11	3	11.1	Ly

155847
X Herculis

10	24	5.6	R
	25	5.8	R

X Herculis

Mo.	Day	Est.	Obs.
11	5	5.8	R
	6	5.6	R
	7	6.3	L
	7	5.7	R
	8	5.5	R
	9	6.2	H
	12	6.1	H
	15	5.5	R
	16	5.4	R
	17	6.3	L

162119
U Herculis

10	31	12.5	He
11	7	12.0	Ly
	10	11.9	B
	12	11.6	Y
	14	12.1	Ly

163137
W Herculis

11	2	8.7	M
	9	9.0	M
	10	8.9	S
	12	9.1	Y
	14	8.7	O
	18	9.7	M

163172
R Urs. Min.

10	24	9.4	R
	25	9.5	R
	26	9.5	R
11	2	9.3	Ly
	2	9.5	M
	4	9.2	R
	5	9.3	R
	6	9.2	R
	6	9.2	Ly
	7	9.5	R
	8	9.2	R
	9	9.4	Bg
	10	9.2	Ly
	10	9.4	E
	12	9.4	R
	13	9.3	Ly
	15	9.3	Ly
	15	9.4	R
	16	9.4	R
	18	9.4	M
	19	9.4	R
	20	9.4	R
	20	9.6	Bg
	21	9.4	R
	22	9.4	R
	23	9.4	R
	27	9.5	M

163266
R Draconis

Mo.	Day	Est.	Obs.
10	25	8.5	R
	26	8.5	R
	31	8.4	He
11	2	8.8	Ly
	2	8.5	M
	3	8.3	He
	4	8.0	Ma
	4	8.6	Ly
	4	8.3	M
	5	8.2	R
	6	8.1	R
	6	8.6	Ly
	7	8.1	R
	7	8.0	M
	7	8.0	He
	8	8.1	R
	9	8.4	Ly
	10	8.0	Ma
	10	8.4	S
	12	7.9	R
	12	8.0	O
	13	8.0	Ly
	13	7.9	He
	14	8.0	O
	15	7.8	R
	15	8.0	Ly
	16	7.9	O
	16	7.7	R
	18	7.8	M
	19	7.8	R
	20	7.6	R
	21	7.6	Bg
	21	7.6	R
	22	7.5	Ma
	22	7.5	R
	23	7.7	O
	23	7.7	R
	23	7.6	He
	28	7.7	M
12	4	7.4	S

164055
S Draconis

11	2	8.8	M
	4	8.9	M
	7	9.1	He
	7	9.1	M
	9	9.2	M
	13	9.4	M
	18	9.0	M
	23	9.8	He

164715
S Herculis

10	11	9.5	He
	24	10.2	R
	25	10.4	R
	26	10.5	R
	31	10.4	He

S Herculis

Mo.	Day	Est.	Obs.
11	4	10.5	Ly
	5	10.6	R
	6	10.5	R
	8	10.4	R
	16	10.8	E

165631
RV Herculis

11	6	13.7	M
	10	13.3	B

171333
u Herculis

10	24.6	4.4	R
	25.6	4.5	R
	26.6	4.8	R
11	3.6	5.5	R
	4.6	5.3	R
	5.6	4.6	R
	6.6	5.2	R
	7.6	4.6	R
	8.6	5.2	R
	12.6	5.2	R
	14.6	5.0	R
	16.6	4.6	R
	17.6	5.2	R
	19.6	4.6	R
	20.6	5.1	R
	21.6	4.6	R
	22.6	5.2	R
	23.6	4.7	R

175111
RT Ophiuchi

11	6	10.2	V

175458
T Draconis

11	2	10.3	M
	4	10.4	M
	6	10.3	V
	7	11.0	Bu
	12	10.4	O
	17	10.4	O
	17	11.2	V
	20	11.2	Bu
	22	9.8	Bg
	23	10.6	O

175519
RY Herculis

11	10	9.3	O
	12	9.3	O
	16	9.5	O
	16	9.5	E
	24	9.5	O

VARIABLE STAR OBSERVATIONS Nov.-Dec., 1914.—Continued.

180531
T Herculis

Mo.	Day	Est.	Obs.
10	21	8.9	L
	24	9.1	R
	25	9.4	R
	26	9.9	R
11	2	9.7	M
	2	9.4	M
	3	10.1	R
	4	10.2	R
	5	10.3	R
	6	11.0	R
	7	11.1	R
	7	9.8	Bu
	8	11.2	R
	9	9.7	Ly
	9	11.0	Hu
	9	11.0	L
	12	11.4	R
	13	11.2	He
	15	11.6	R
	17	10.0	Ly
	17	11.6	L
	18	10.6	M
	27	10.7	He

181136
W Lyrae

Mo.	Day	Est.	Obs.
11	7	11.2	Bu
	9	11.3	M
	9	10.8	Hu
	10	10.9	E
	12	10.5	O
	13	11.0	M
	14	10.4	Bg
	15	10.0	Hy
	16	10.0	Hy
	18	9.6	M
	19	9.8	Hy
	20	9.5	Hy
	22	9.6	Hy
	23	9.7	R
	28	9.2	B

183308
X Ophiuchi

Mo.	Day	Est.	Obs.
11	1	6.2	Ma
	3	6.8	Ly
	4	6.4	Ma
	6	5.9	V
	7	6.7	Bu
	7	6.5	L
	8	6.3	Ma
	9	6.7	Ly
	11	6.7	Ly
	13	6.6	Ma
	14	6.5	Ma
	17	6.8	V
	17	6.9	L
	18	6.8	M
	22	6.8	Ma

184205
R Scuti

Mo.	Day	Est.	Obs.
10	24.6	5.8	R
	25.6	6.0	R
	26.6	6.0	R
11	1	5.7	Ma
	2.5	5.7	Ly
	3.6	5.9	R
	4	5.7	Ma
	4.5	5.7	Ly
	4.6	5.9	R
	5	5.4	Hy
	5.6	5.8	R
	6	5.9	Hy
	6.6	5.9	R
	7	5.8	Bu
	7	5.8	Hy
	7.5	5.8	Ly
	7.6	5.9	R
	8	5.5	Ma
	8.6	5.8	R
	9	5.3	L
	9	5.2	H
	9.5	5.8	Ly
	10.4	5.8	O
	10.5	6.0	St
	11.4	5.5	Pi
	11.4	5.9	O
	12	5.3	H
	12.4	5.9	O
	12.5	5.8	Ly
	12.6	6.0	R
	13	5.4	L
	13	5.4	Ma
	13.6	5.9	R
	14	5.4	Ma
	14	6.0	Ph
	14.4	5.8	O
	14.5	5.8	Ly
	15	5.3	H
	15	5.7	Hy
	15.6	5.9	R
	16	5.6	Hy
	16.4	5.8	O
	16.6	5.7	R
	17.4	5.8	O
	17.5	5.9	Ly
	18.5	5.8	Ly
	19	5.8	Hy
	19	5.9	Ph
	19.5	5.8	Ly
	19.6	5.7	R
	20	5.7	Hy
	20.6	5.9	R
	21.5	5.7	Ly
	22	5.5	Ma
	22	5.6	Hy
	23.4	5.6	O
	23.5	5.8	Ly

184633
***β* Lyrae**

Mo.	Day	Est.	Obs.
10	24.6	3.7	R
	25.6	3.6	R
	26.6	3.5	R
	27.6	3.6	R
	28.6	3.8	R
	30.6	3.8	R
11	1.6	3.6	R
	2.6	3.4	R
	3.6	3.6	R
	4.6	3.8	R
	5.6	3.9	R
	6.6	3.6	R
	7.6	3.4	R
	8.6	3.4	R
	12.6	3.6	R
	13.6	3.5	R
	14.6	3.4	R
	15.6	3.5	R
	16.6	3.8	R
	17.6	3.9	R
	18.6	3.6	R
	19.6	3.4	R
	20.6	3.5	R
	21.6	3.5	R
	22.6	3.4	R
	23.6	3.7	R

185243
R Lyrae

Mo.	Day	Est.	Obs.
10	24.6	4.2	R
	25.6	4.8	R
	26.6	4.5	R
	27.6	4.8	R
	28.6	4.5	R
11	3.6	4.5	R
	4.6	4.5	R
	5.6	4.4	R
	6.6	4.6	R
	7.6	4.5	R
	8.6	4.6	R
	12.6	4.6	R
	13.6	4.7	R
	14.6	4.7	R
	15.6	4.6	R
	17.6	4.7	R
	19.6	4.6	R
	20.6	4.7	R
	21.6	4.6	R
	22.6	4.6	R
	23.6	4.6	R

190108
R Aquilae

Mo.	Day	Est.	Obs.
11	3	6.7	M
	7	6.4	Bu
	9	6.1	L
	13	6.1	L
	28	6.5	B

190926
X Lyrae

Mo.	Day	Est.	Obs.
10	24	9.3	R
	25	9.3	R
	26	9.4	R
11	3	9.2	Ly
	3	9.2	R
	3	9.2	M
	4	9.2	R
	5	9.2	R
	6	9.2	R
	7	9.2	R
	7	9.2	Bu
	8	9.3	R
	9	9.2	Ly
	12	9.2	R
	13	9.3	M
	13	9.1	R
	14	9.2	Bg
	14	9.3	R
	15	9.2	R
	15	9.5	Hy
	16	9.0	Hy
	16	9.2	R
	17	9.2	R
	19	9.2	R
	19	8.5	Hy
	20	9.2	R
	20	8.5	Hy
	21	9.3	R
	22	9.3	R
	22	9.4	Hy
	23	9.3	R
	23	9.0	M
	27	9.1	He

191033
RY Sagittarii

Mo.	Day	Est.	Obs.
10	25	7.3	R
	26	7.4	R
11	5	7.3	R
	6	7.2	R
	7	7.3	R

191350
TZ Cygni

Mo.	Day	Est.	Obs.
10	21	10.4	L
11	10	10.7	L

193311
RT Aquilae

Mo.	Day	Est.	Obs.
11	7	11.3	L
	15	11.5	L

193449
R Cygni

Mo.	Day	Est.	Obs.
11	6	13.0	M
	12	12.0	B

193732
TT Cygni

Mo.	Day	Est.	Obs.
10	21	7.3	L
	24	8.5	R
	25	8.6	R
	26	8.6	R
11	2	7.8	Ly
	2	7.8	M
	2	7.8	Bb
	3	8.5	R
	4	8.6	R
	4	7.9	Ma
	5	8.6	R
	5	7.3	Hy
	6	8.6	R
	6	7.5	Hy
	7	8.6	Bu
	7	8.5	R
	7	7.4	Hy
	7	7.9	Ly
	8	8.6	R
	10	8.0	L
	10	8.0	Ly
	10	8.0	Ma
	11	7.9	Hu
	12	8.5	R
	12	7.7	Hy
	13	8.5	M
	13	9.0	L
	13	8.4	R
	13	8.0	Bg
	14	7.8	B
	14	8.5	R
	15	7.7	Hy
	15	8.5	R
	16	7.6	Hy
	16	8.5	R
	17	8.3	Ly
	18	8.2	M
	19	8.5	R
	19	7.3	Hy
	20	8.5	R
	20	7.5	Hy
	21	8.5	R
	22	8.5	R
	22	8.0	Ma
	22	7.4	Hy
	23	7.9	B
	23	8.1	M
	23	8.5	R

194048
RT Cygni

Mo.	Day	Est.	Obs.
10	21	8.4	L
	24	8.3	R
	25	8.2	R
	26	8.3	R
11	2	8.5	Bb
	3	8.3	Ly
	3	8.4	R
	3	8.4	M
	4	8.7	He
	4	8.0	Ma
	4	8.3	R

VARIABLE STAR OBSERVATIONS Nov.-Dec., 1914—Continued.

RT Cygni

Mo.	Day	Est	Obs.
11	5	8.3	R
	6	8.5	M
	6	8.4	R
	7	8.6	Bu
	7	8.4	R
	7	8.5	R
	9	8.3	Hu
	9	8.4	Ly
	10	8.4	L
	10	8.3	Ma
	10	8.8	He
	11	8.6	Bg
	11	8.5	Ly
	12	8.5	R
	12	8.6	O
	12	8.4	B
	13	8.7	Ly
	13	8.5	R
	13	8.6	M
	14	8.6	R
	16	8.7	R
	16	8.6	O
	17	8.8	R
	18	8.7	M
	19	8.6	R
	20	8.9	R
	21	9.2	Bg
	21	8.9	R
	21	8.7	S
	22	9.5	St
	22	8.9	Ma
	22	9.1	R
	23	9.1	R
	23	8.9	O
	23	9.0	He
	23	8.8	B
	23	8.8	M
	27	8.9	He
12	4	9.6	O

194348
TU Cygni

10	21	11.7	L
11	2	11.3	Bb
	2	11.3	Ly
	6	12.2	M
	9	12.3	Hu
	11	12.3	Hu
	21	11.0	Bg

194604
X Aquilae

11	9	12.0	M
	10	13.4	B

194632
χ Cygni

10	21	6.7	L
	24	7.2	R
	25	7.3	R
	26	7.2	R

χ Cygni

Mo.	Day	Est.	Obs.
11	2	6.3	Bb
	2	6.5	Ly
	2	6.3	M
	3	6.7	R
	4	6.3	Ly
	4	6.2	Ma
	4	6.2	M
	4	6.8	R
	5	6.7	R
	5	6.0	Ma
	5	6.2	Hy
	6	6.5	R
	6	6.2	Hy
	7	6.3	Ly
	7	5.9	He
	7	5.9	Bu
	7	6.3	R
	7	6.0	Hy
	7	5.8	M
	8	5.9	Hy
	8	6.1	R
	10	5.4	L
	10	5.9	Ma
	10	5.7	E
	10	6.2	Ly
	10	6.1	O
	11	6.9	Hu
	11	5.9	O
	11	5 9	Bg
	12	5.6	M
	12	5.6	Hy
	12	5.6	O
	12	5.5	B
	12	6.2	R
	13	5.6	Ma
	13	5.9	He
	13	6.0	Ly
	13	5.3	L
	13	5.9	R
	14	5.5	R
	14	5.6	O
	15	5.5	Hy
	15	5.6	R
	16	5.4	O
	16	5.5	Hy
	16	5.7	R
	17	5.3	O
	17	5.8	Ly
	17	5.4	Ma
	18	5.8	Ly
	18	5.5	M
	19	5.3	Hy
	19	5.4	R
	20	5.4	O
	20	5.4	Hy
	20	5.5	R
	21	5.4	Bg
	21	5.6	Ly

χ Cygni

Mo.	Day	Est.	Obs.
11	21	5.3	R
	22	5.1	R
	22	5.3	Hy
	22	5.2	Ma
	23	5.5	Ly
	23	5.4	M
	23	5.3	O
	23	4.9	B
	23	5.1	R
	23	5.6	He
	24	5.3	O
	27	5.7	He
	28	5.3	O
	29	5.3	O
12	3	5.3	O
	4	5.2	O

194700
η Aquilae

10	24.6	4.5	R
	25.6	4.2	R
	26.6	3.8	R
	27.6	4.0	R
	28.6	3.6	R
	30.6	3.6	R
11	2.6	3.7	R
	3.6	3.7	R
	4.6	4.2	R
	5.6	4.2	R
	6.6	4.6	R
	7.6	4.6	R
	8.6	4.2	R
	12.6	4.4	R
	13.6	4.4	R
	14.6	4.3	R
	15.6	4.2	R
	16.6	4.1	R
	17.6	4.0	R
	18.6	4.2	R
	19.6	4.4	R
	20.6	4.6	R
	21.6	4.6	R
	22.6	4.9	R
	23.6	4.1	R

195116
S Sagittae

10	24.6	5.6	R
	25.6	5.5	R
	26.6	5.5	R
11	3.6	5.5	R
	4	5.5	Ma
	4.6	5.6	R
	5	5.6	Ma
	5.6	5.6	R
	6.6	5.8	R
	7.5	5.4	Bu
	7.5	5.5	Mu
	7.6	5.9	R
	8	6.1	Ma

S Sagittae

Mo.	Day	Est.	Obs.
11	8.6	6.2	R
	8.6	5.6	Mu
	9.7	5.7	Mu
	10	6.0	St
	10.4	6.0	O
	10.5	5.7	Mu
	11	5.8	Ma
	11.4	5.4	O
	12.4	5.4	O
	12.6	5.6	R
	13	5.8	Ma
	13.6	5.6	R
	14	5.7	Ma
	14.4	5.3	O
	14.6	5.6	R
	15	5.8	St
	15.5	5.5	Mu
	15.6	5.8	R
	16.4	5.8	O
	16.6	6.2	R
	16.7	5.6	Mu
	17	6.1	Ma
	17.4	6.0	O
	17.6	5.7	Mu
	17.6	6.2	R
	18.6	6.2	R
	19.6	5.7	Mu
	19.6	6.0	R
	20.5	5.4	O
	20.6	5.6	R
	21.6	5.7	R
	22	5.6	Ma
	22	5.6	St
	22.6	5.7	R
	23.4	5.4	O
	23.6	5.7	R
	24.4	5.7	O
	28.4	5.4	O
	29.4	5.3	O
12	3.4	5.7	O
	4.4	5.9	O

195849
Z Cygni

11	6	12.8	M
	21	12.5	B

200647
SV Cygni

10	21	9.5	L
	24	9.6	R
	25	9.7	R
	26	9.7	R
11	3	9.5	R
	4	9.5	R
	5	9.5	R
	5	8.2	Hy
	6	9.7	R
	6	7.8	Hy
	7	9.0	Bu

SV Cygni

Mo.	Day	Est	Obs.
11	7	9.6	R
	7	8.1	Hy
	8	9.8	R
	8	8.0	Hy
	8	9.2	Ly
	10	9.0	Ma
	11	8.3	Hu
	12	9.2	Ly
	12	9.6	R
	12	9.1	M
	12	8.5	Hy
	13	9.5	R
	14	9.6	R
	15	9.6	R
	15	8.2	Hy
	16	9.5	R
	16	8.3	Hy
	17	9.5	R
	17	9.1	Ly
	19	9.6	R
	19	8.4	Hy
	20	9.6	R
	20	8.4	Hy
	21	9.6	R
	22	9.6	R
	22	8.2	Hy
	22	9.0	Ma
	23	9.7	R
	28	9.0	B

200715a
S Aquilae

10	24	9.4	R
	25	9.5	R
	26	9.4	R
11	2	9.2	M
	3	9.5	R
	4	9.6	R
	5	9.6	R
	7	9.8	R
	7	9.5	Bu
	8	9.8	R
	9	10.0	M
	12	9.7	R
	13	9.6	R
	14	9.6	R
	15	9.6	R
	16	9.8	R
	17	10.4	R
	19	10.0	R
	20	10.7	R
	21	10.8	R
	22	11.0	R
	23	10.9	R

200715b
RW Aquilae

10	24	8.8	R
	25	9.0	R
	26	9.0	R

VARIABLE STAR OBSERVATIONS Nov.-Dec., 1914.—Continued.

RW Aquilae

Mo.	Day	Est.	Obs.
11	2	9.1	M
	3.6	9.0	R
	3.6	9.1	R
	4.6	9.0	R
	5.6	9.1	R
	5.6	8.9	R
	6.6	8.9	R
	7.5	8.4	Bu
	7.6	9.0	R
	7.7	9.0	R
	8.6	8.8	R
	12.6	8.9	R
	13.4	9.0	R
	14.6	8.8	R
	15.6	8.9	R
	15.6	9.0	R
	16.6	8.9	R
	17.6	9.0	R
	17.6	8.9	R
	19.5	9.0	R
	20.6	9.0	R
	20.6	9.1	R
	21.6	8.9	R
	21.7	8.9	R
	22.6	8.9	R
	23.6	8.9	R
	23.6	9.0	R

200812
RU Aquilae

Mo.	Day	Est.	Obs.
11	10	12.2	B

200916
R Sagittae

Mo.	Day	Est.	Obs.
10	24	10.0	R
	25	10.2	R
	26	10.2	R
11	3	9.0	R
	4	9.0	R
	5	9.1	R
	6	9.0	R
	7	8.4	R
	8	8.2	R
	10	8.8	B
	12	9.1	R
	13	8.2	R
	14	8.9	R
	15	8.9	R
	16	9.0	R
	17	8.8	R
	19	9.0	R
	20	9.1	R
	21	9.0	R
	22	9.1	R
	23	9.0	R

200906
Z Aquilae

Mo.	Day	Est.	Obs.
11	28	9.7	Ba

200938
RS Cygni

Mo.	Day	Est.	Obs.
10	21	7.2	L
	25	7.1	R
	26	7.2	R
11	3	7.1	Ly
	3	7.3	R
	4	7.4	R
	4	7.2	Ma
	5	7.2	R
	6	7.1	R
	7	7.1	R
	8	7.2	R
	9	7.2	Ly
	10	7.5	Ma
	10	7.3	L
	12	7.2	Ly
	12	7.1	R
	13	7.6	M
	13	7.2	R
	14	7.2	R
	15	7.3	R
	16	7.1	Ly
	16	7.1	R
	17	7.2	R
	19	7.2	R
	20	7.2	R
	21	7.2	Ly
	21	7.2	R
	22	7.4	Ma
	22	7.2	R
	23	7.1	R
	22	7.3	Ly

201008
R Delphini

Mo.	Day	Est.	Obs.
11	2	10.3	M
	10	10.3	O
	13	10.6	M
	28	10.7	B

201121
RT Capricorni

Mo.	Day	Est.	Obs.
10	26	7.7	R
11	3	7.5	Ly
	4	7.8	R
	5	7.8	R
	6	7.9	R
	7	7.9	R
	9	6.4	L
	12	7.7	R
	13	7.4	M
	13	6.4	L
	13	7.6	R
	14	7.8	R
	15	7.8	R
	16	7.8	R
	19	7.7	R
	20	7.6	R
	22	7.8	R

201130
SX Cygni

Mo.	Day	Est.	Obs.
11	9	11.6	Hu
	23	9.2	M

201647
U Cygni

Mo.	Day	Est.	Obs.
	24	7.7	R
	25	7.7	R
	26	7.8	R
11	3	7.1	Ly
	3	7.7	R
	4	7.6	R
	5	7.6	R
	6	7.5	R
	7	7.2	Bu
	7	7.5	R
	7	6.8	Hy
	8	7.5	R
	8	7.1	Hy
	12	7.6	M
	12	7.7	R
	12	7.1	O
	12	7.3	Ly
	12	6.8	Hy
	13	7.7	R
	13	8.2	L
	14	7.7	R
	14	7.3	Ly
	15	7.9	Hy
	15	7.7	R
	16	7.8	R
	16	7.0	S
	16	6.9	Hy
	17	7.8	R
	19	7.7	R
	19	7.2	Hy
	20	7.7	R
	20	7.0	Hy
	21	7.7	R
	22	7.7	R
	22	6.8	Hy
	23	7.1	O
	23	7.7	R

202539
RW Cygni

Mo.	Day	Est.	Obs.
	22	8.4	He
11	2	8.4	Ly
	2	8.5	M
	4	8.9	M
	4	8.7	Ma
	5	7.5	Hy
	6	8.3	Hy
	7	8.6	Bu
	7	8.0	Hy
	7	8.9	M
	7	8.9	He
	8	8.5	Ly
	10	9.0	He
	10	9.0	Ma
	11	8.5	Pi

RW Cygni

Mo.	Day	Est.	Obs.
11	12	8.0	Hy
	13	8.8	Bg
	13	8.8	M
	13	8.8	He
	14	8.8	Ph
	15	7.8	Hy
	16	7.7	Hy
	19	7.8	Hy
	20	7.7	Hy
	22	8.7	Ma
	22	7.7	Hy
	22	9.1	M
	23	8.7	He
	28	8.6	He

202817
Z Delphini

Mo.	Day	Est.	Obs.
11	7	8.7	V
	17	9.5	V

202946
SZ Cygni

Mo.	Day	Est.	Obs.
10	24	9.4	R
	25	9.5	R
	26	9.4	R
11	2	9.6	M
	3	9.9	R
	4	10.0	R
	4	9.5	M
	5	9.7	R
	6	9.7	R
	6	9.8	Bu
	7	9.5	R
	7	9.4	Ly
	8	9.3	R
	9	9.3	Ly
	11	9.5	Ly
	11	9.5	Hu
	12	9.6	Ly
	12	9.6	R
	13	9.6	R
	13	9.6	M
	13	9.7	Ly
	14	9.9	R
	15	9.2	R
	16	10.6	R
	17	10.6	R
	19	9.3	R
	20	9.8	R
	21	9.9	R
	21	9.4	B
	22	9.6	R
	23	8.9	M
	23	9.4	R

202954
ST Cygni

Mo.	Day	Est.	Obs.
11	11	10.9	Hu
	12	9.8	B
	16	10.4	Y
	21	10.2	B

203816
S Delphini

Mo.	Day	Est.	Obs.
11	12	11.0	Y
	23	11.6	Y

203847
V Cygni

Mo.	Day	Est.	Obs.
11	12	9.1	B
	13	10.0	M
	18	10.0	Bg
	21	9.0	B

204016
T Delphini

Mo.	Day	Est.	Obs.
11	9	10.5	M
	12	11.2	Y
	23	11.6	Y

204405
T Aquarii

Mo.	Day	Est.	Obs.
11	2	10.9	Ly
	6	11.1	Ly
	9	11.2	Ly
	12	11.4	Ly
	14	12.3	B
	16	11.5	Ly

204846
RZ Cygni

Mo.	Day	Est.	Obs.
11	23	12.2	Y

205017
X Delphini

Mo.	Day	Est.	Obs.
11	27	8.5	B

205923
R Vulpeculae

Mo.	Day	Est.	Obs.
10	21	8.3	L
11	3	8.6	Ly
	6	8.2	Bu
	7	8.8	R
	9	7.8	M
	9	8.4	Ly
	11	8.0	Hu
	12	8.6	O
	12	8.9	R
	13	8.4	Ly
	14	9.1	R
	16	9.0	R
	16	9.1	O
	16	8.8	E
	17	9.2	R
	19	9.1	R
	20	9.3	R
	20	9.2	O
	21	9.2	R
	22	9.3	R
	22	9.1	Bg
	23	9.3	O
	23	9.4	R
	27	9.3	He

VARIABLE STAR OBSERVATIONS Nov.-Dec., 1914—Continued.

210129
TW Cygni

Mo.	Day	Est.	Obs.
11	16	11.8	Y

210116
RS Capricorni

Mo.	Day	Est.	Obs.
11	2	8.6	Ly
	12	8.6	Ly
	13	8.6	M
	15	8.8	Bg
	17	8.9	Ly
	19	8.8	R
	20	8.8	R
	21	9.1	R
	22	9.0	R
	23	8.4	M
	23	9.1	R

210382
X Cephei

Mo.	Day	Est.	Obs.
11	14	13.0	Y

210868
T Cephei

Mo.	Day	Est.	Obs.
10	31	6.5	He
11	4	6.2	Ly
	4	5.9	Ma
	6	6.2	Bu
	7	6.1	Ly
	9	5.9	L
	9	6.2	Ly
	10	5.8	He
	10	6.6	O
	10	6.0	Ma
	12	6.2	Ly
	13	5.6	He
	13	6.0	Ma
	13	6.2	M
	14	5.8	Bg
	14	6.5	O
	15	6.1	Hy
	16	5.6	Hy
	16	6.0	Ly
	17	5.7	Ma
	17	6.6	O
	17	5.8	L
	19	6.0	Hy
	20	6.1	Ly
	20	6.1	Hy
	20	6.5	O
	21	5.6	Hu
	21	5.5	Ma
	22	6.1	Hy
	23	6.4	O
	23	5.6	He
	23	5.9	Ly
	27	5.5	He
	28	6.4	O
12	4	6.4	O

211615
T Capricorni

Mo.	Day	Est.	Obs.
11	7	10.3	L
	13	10.5	L

213244
W Cygni

Mo.	Day	Est.	Obs.
10	21	6.4	L
	24	6.8	R
	25	6.9	R
	26	6.7	R
11	3	6.7	R
	4	6.8	R
	5	6.8	R
	6	6.8	R
	6	7.2	Bu
	7	6.8	R
	8	6.9	R
	9	5.9	L
	12	6.7	R
	13	5.7	R
	14	6.9	R
	15	6.7	R
	16	6.7	R
	17	6.8	R
	19	6.8	R
	20	6.9	R
	21	6.6	R
	22	6.8	R
	23	6.6	R

213678
S Cephei

Mo.	Day	Est.	Obs.
	13	9.3	M
	21	8.9	Hu

213753
RU Cygni

Mo.	Day	Est.	Obs.
11	2	9.0	M
	3	8.6	Ly
	18	9.0	Bg

213843
SS Cygni

Mo.	Day	Est.	Obs.
10	21.4	11.9	L
	29.6	11.7	E
11	2.6	11.7	Ly
	4.5	11.6	He
	5	9.6	Hy
	5.6	9.7	R
	5.6	10.1	Ly
	6	8.5	Hy
	6.5	9.0	J
	6.6	8.3	R
	6.6	8.4	J
	7	8.6	Hy
	7.5	8.4	J
	7.5	8.7	He
	7.6	8.4	R
	7.6	8.6	M
	8	9.0	Hy
	8.5	8.6	Ly
	9.2	8.9	L
	9.4	8.9	J
	9.5	8.9	Ly
	9.6	8.6	M
	10.2	9.3	L
	10.4	9.5	O

SS Cygni

Mo.	Day	Est.	Obs.
11	10.5	9.3	He
	10.5	9.3	Ly
	10.5	9.2	J
	10.5	9.3	E
	10.6	9.2	Ma
	11.4	9.5	O
	11.5	10.2	J
	11.5	9.5	Ma
	11.5	9.6	Hu
	11.5	9.8	Pi
	11.6	9.7	Ly
	12	9.5	Hy
	12.4	10.5	J
	12.5	10.4	O
	12.5	10.2	Ly
	12.6	10.0	R
	13.2	10.5	L
	13.5	11.0	Ly
	13.5	10.9	Pi
	13.5	10.9	J
	13.6	11.1	M
	13.6	10.8	He
	14.5	11.6	He
	14.6	11.4	Ly
	14.6	11.6	M
	16.5	12.2	J
	16.6	11.8	E
	16.6	11.5	Ly
	17.5	11.6	Ly
	17.5	12.1	J
	17.5	11.6	Hu
	18.5	12.3	J
	18.5	12.0	M
	18.6	12.0	E
	19.5	11.6	Ly
	19.6	11.8	E
	20.6	11.7	E
	21	12.0	B
	21.5	11.7	Ly
	21.5	12.0	Hu
	21.5	12.0	E
	22.6	12.0	E
	22.7	12.0	M
	23.6	11.7	Ly
	28.5	11.9	He

213937
RV Cygni

Mo.	Day	Est.	Obs.
10	21	6.3	L
	24	8.2	R
	25	8.2	R
11	2	7.7	M
	3	6.8	Ly
	4	8.1	R
	4	7.3	Ma
	5	8.2	R
	6	6.4	Bu
	6	8.1	R

RV Cygni

Mo.	Day	Est.	Obs.
11	7	8.1	R
	10	6.7	Ly
	10	7.6	Ma
	11	7.2	Hu
	12	8.0	R
	12	8.0	M
	13	6.7	Ly
	14	8.0	R
	15	8.1	R
	17	7.6	Ma
	17	8.0	R
	18	7.6	Bg
	19	7.9	R
	20	8.0	R
	21	8.2	R
	21	7.1	Ma
	22	8.1	R
	22	7.0	Ma
	23	8.1	M
	23	8.1	R
	28	7.0	B

214024
RR Pegasi

Mo.	Day	Est.	Obs.
11	19	9.4	E

220613
Y Pegasi

Mo.	Day	Est.	Obs.
11	12	9.6	O

220714
RS Pegasi

Mo.	Day	Est.	Obs.
11	7	8.9	V
	12	9.0	O
	17	8.9	V

222439
S Lacertae

Mo.	Day	Est.	Obs.
11	16	11.4	Y

222557
δ Cephei

Mo.	Day	Est.	Obs.
10	24.6	4.0	R
	25.6	4.0	R
	26.6	3.6	R
	27.6	3.6	R
	28.6	4.0	R
11	2.6	3.6	R
	3.6	3.6	R
	4.6	3.8	R
	5.6	3.9	R
	6.6	3.7	R
	7.6	3.8	R
	8.6	4.0	R
	12.6	3.9	R
	13.6	4.2	R
	14.6	4.0	R
	15.6	4.3	R
	16.6	3.6	R
	17.6	3.9	R
	18.6	4.0	R

δ Cephei

Mo.	Day	Est.	Obs.
11	19.6	4.1	R
	20.6	4.2	R
	21.6	4.0	R
	22.6	3.6	R
	23.6	3.9	R

223841
R Lacertae

Mo.	Day	Est.	Obs.
11	16	12.8	Y

225120
S Aquarii

Mo.	Day	Est.	Obs.
11	12	12.0	Y

230110
R Pegasi

Mo.	Day	Est.	Obs.
10	24	9.5	R
	25	9.4	R
	26	9.5	R
	31	8.7	He
11	3	8.9	Ly
	3	8.7	M
	4	8.8	R
	4	8.7	Ma
	5	9.0	R
	5	8.3	Hy
	6	8.6	R
	6	8.5	Hy
	6	8.8	Ly
	7	8.6	R
	7	8.3	Hy
	7	8.6	Bu
	9	8.6	Mu
	10	8.6	Ly
	10	8.5	Ma
	10	8.2	St
	10	8.7	O
	10	8.6	He
	10	8.5	Bu
	11	8.7	St
	12	8.1	O
	12	8.5	R
	12	7.9	Hy
	13	8.4	Ly
	13	8.2	Pi
	13	8.3	R
	13	8.3	He
	14	8.5	R
	14	8.2	O
	15	8.4	Ly
	15	8.3	Bg
	15	8.5	R
	15	7.5	Hy
	16	8.6	R
	16	8.1	Hy
	16	8.1	O
	16	8.4	Mu
	17	8.2	Pi
	17	8.1	Ma
	17	8.5	R

VARIABLE STAR OBSERVATIONS Nov.-Dec., 1914.—Continued.

R Pegasi				V Cassiop.				ST Androm.				R Aquarii				R Aquarii			
Mo.	Day	Est.	Obs.	Mo.	Day	Est.	Obs.	Mo.	Day	Est.	Obs.	Mo.	Day	Est.	Obs.	Mo	Day	Est.	Obs.
11	19	8.3	R	11	2	11.5	Ly	11	17	9.0	Hu	11	7	8.5	Hy		20	8.5	Hy
	19	8.0	Hy		12	12.4	Y		18	9.8	Bu		7	8.4	Ly		21	9.1	R
	20	8.5	R		18	10.9	Bg		20	9.8	Bu		10	8.9	Ma		22	9.1	R
	20	8.5	Hy		231425				23	9.7	Bg		10	8.6	Ly		22	9.0	Ma
	20	8.3	O		W Pegasi				27	9.4	He		12	8.5	R		22	8.8	Hy
	21	8.3	R	11	4	11.3	Ly		29	9.2	E		12	8.5	Hy		23	9.2	R
	21	7.7	Hu		8	11.4	Ly		*233815*				13	8.6	Ly		235350.		
	21	7.9	Ma		21	11.2	Hu		R Aquarii				14	8.7	R		R Cassiop.		
	22	7.7	Hy					10	24	8.2	R		15	8.5	Hy	11	1	6.5	He
	22	8.3	R		231508				25	8.3	R		15	8.7	Ly		4	6.7	M
	23	7.8	O		S Pegasi			11	2	8.2	Ly		15	8.8	R		11	6.7	O
	23	8.2	R	11	12	11.4	O		4	8.7	R		16	8.8	Hy		27	7.3	He
	23	8.0	He		28	10.7	B		4	8.5	M		16	8.8	R		235525		
	27	7.9	He		233335				5	8.0	Hy		17	8.7	Ly		Z Pegasi		
	28	7.7	O		ST Androm.				5	8.6	R		17	8.8	R	11	17	11.1	V
12	4	7.7	O	11	1	9.5	He		6	8.5	Hy		17	8.9	Pi		235939		
					4	9.4	Ly		6	8.7	R		19	8.6	R		SV Androm.		
					12	9.4	O		7	8.6	R		19	8.5	Hy	11	17	10.5	Hu

No. of observations, 1784; No. of stars observed, 163; No. of observers, 24.

Mr. McAteer and Mr. Herriott, our Pittsburg members, have the rare opportunity of using occasionally the 13″ refractor of the Allegheny Observatory. They are thus enabled to observe many of the faint variables and establish minima, observations of special value.

The observations of the variable 230110 R Pegasi have had an especial interest of late. In 1913 when this variable was rising and reached 8.6 magnitude, it waned 0.6 of a magnitude and then rose to a maximum of 7.9 magnitude, clearly indicating a secondary maximum. The observations during the past two months when plotted show no deviation from a uniform and steady rise at the point indicated. Such features of our work lend great interest and deprive it of monotony.

Lack of agreement in the estimates of 180531 T Herculis, and 200647 SV Cygni call for special care in the observation of these variables.

Miss Young, Mr. Eaton, and Mr. Lacchini observed the recent rise of the variable 060547 SS Aurigae about November 18. This variable is in the same class with 213843 SS Cygni, extremely irregular, and should be observed at every opportunity by all our members.

Thanks are due Messrs. Herriott, Lindsley, and Pickering, for blue prints for distribution. No small part of the Secretary's task is that of supplying observing material to members. This calls for a large number of prints. Tracings and blue prints sent in for distribution by members are always most welcome. An interchange of charts by members in touch with each other is to be commended.

The rapid rise of the variable 123160 T Ursae Majoris is an interesting feature of this report. Mr. Richter calls attention to the observations of *152714* RU Librae recorded in the September report. About August 1 a maximum of approximately 8.2 magnitude was observed. In 1913 Mr. Bancroft observed a rise of a magnitude in twenty-three days. This year Mr. Lacchini's observations indicate that this variable increased in brilliance 2.5 magnitude in twenty-two days. Dr. Hartwig's calculated date of maximum was February 15, 1914, over five months prior to the observed maximum.

Mr. Mach corrects an error in the November report. The estimate 8.5 magnitude for the variable 163266 R Draconis credited to him should read 9.5 magnitude.

The rise of 213843 SS Cygni on November 6 was well observed.

The publication of the G.M.T. of observations of irregular variables is an added feature of the reports that increases their value and service. Several well known short period variables were observed by Mr. Richter, good examples of what can be accomplished with a field glass.

With this report we conclude our first year of work on the so-called neglected variables, eighty-seven in number. With five exceptions we have obtained positive observations for every variable in this list, and a total of 1658 observations. Because of the faintness of these variables, even at maximum, a great many of our observations have been negative, but even these have their value, and we have the satisfaction of knowing that in our work on these stars we have already contributed data of value to science.

The following members have contributed to this report:

Messrs. Barbour, Bolfing, Bouton, Burbeck, Eaton, Harriott, Hay, Hunter, Huntington, Jacobs, Lacchini, Lindsley, Mach, McAteer, Mundt, Olcott, Phillips, Pickering, Richter, Spinney, Stepka, Vrooman, Miss Swartz, and Miss Young.

WILLIAM TYLER OLCOTT,
Corresponding Sec'y.

Norwich, Conn.
Dec. 10, 1914.

GENERAL NOTES.

Professor H. F. Newall has been elected president of the Cambridge Philosophical Society.

Mr. Adam Massinger, assistant at the Royal Observatory at Heidelberg died in battle near Ypres on October 21, 1914.

Professor N. C. Dunér, director of the Observatory at Upsala, Sweden, died at Stockholm on November 10, 1914.

Dr. Paul V. Neugebauer has been appointed observer in the astronomical institute of the University of Berlin in succession to Professor P. Lehmann. (*Science* Dec. 11, 1914).

Mr. W. S. Adams, Mount Wilson Solar Observatory, California; *Professor H. Andoyer*, professor of physical astronomy in the Sorbonne, Paris; and *Dr. F. Schlesinger*, director of the Allegheny Observatory, and professor of astronomy, University of Pittsburgh, U. S. A., have been elected associates of the Royal Astronomical Society. (*Nature*, Nov. 19, 1914.)

The Amherst Eclipse Expedition.—Professor David Todd gives an account of Amherst Eclipse expedition in the December number of the *American Journal of Science*. Professor Todd was located at Smala, about 100 miles southeast of Kieff. Thin clouds drifting over the sun during the entire time of total eclipse were sufficient to obscure the outer corona completely, although two of the photographs taken show the inner corona very satisfactorily.

Publications of the Lick Observatory.—Volume XII of the Publications of the Lick Observatory contains measures of double stars made with the thirty-six inch and twelve-inch refractors by Astronomer R. G. Aitken during the years 1895-1912. This is a volume of about 200 quarto pages, and contains measures of 552 of Burnham's doubles, 226 of Struve's, 113 of Hough's 67 of Otto Struve's, and 243 miscellaneous pairs. It does not include the new doubles, numbering nearly three thousand, which have been discovered by Aitken himself in the systematic survey of the sky which he has been carrying on with the 36-inch telescope since July 1899.

The accuracy of the measures is indicated by a table of probable errors determined by comparison of observations of the same star on different nights and it is interesting to see that both telescopes give practically the same probable error for pairs of corresponding difficulty.

The volume contains measures of 93 binary systems for which orbits have been computed by various persons. Professor Aitken regards 56 of the orbits as fairly reliable and by comparison of his measures with the ephemerides he obtains some idea of the probable size of his systematic errors of measurement, as shown in the following table:

	$\Delta\theta$	$\Delta\rho$
24 pairs with distances 0″.5 or less	±2.°85	±0.″035
20 pairs with distances between 0″.5 and 1″.1	±2.41	±0.070
12 pairs with distances 1″.1 or greater	±1.31	±0.093

For 26 of these pairs Professor Aitken has computed new elements.

The Transit of Mercury.—I observed the transit of Mercury with my five-inch Clark refractor on November 7, at my residence here. A 63 power eyepiece with a sun diagonal was used. Thirty members of the class in astronomy of Lowell High School were present, accompanied by their teacher, Miss Alice O. Stickney. All had an excellent view of the transit.

The morning was clear except for a few scattering clouds over the sunrise which prevented observations until 8 o'clock. After that hour the seeing was quite good.

The disk of Mercury was round and black and its outline sharp and distinct. The limb of the sun was a little unsteady. I was able to follow the planet until the edge of its disk became a very small, curved notch in the sun's limb; in fact until it disappeared completely.

Two large sun spots, almost diametrically opposite the point of egress, made an interesting addition to the observation. The spots were larger than the disk of Mercury and showed considerable detail. Half way between the spots and the point of egress, but not quite in line, was a group of about a dozen very small grayish brown specks. These minute spots covered about one half as much space as the two large ones. Although they were faint and could easily have been overlooked, they were not really difficult to see. Several of the students saw them. They looked to me like very faint blow holes or the remains of a small spot which had perhaps just broken up.

D. Henry Scarlett.

Lowell, Mass., R.F.D. No. 1.

The New Observatory at Oakland, Cal.—Mr. Charles Burckhalter director of the Chabot Observatory at Oakland, California, is rejoicing over the acquisition of a fine site for his new observatory. According to the Oakland Enquirer of November 25, the Board of Education of Oakland have authorized the purchase

of thirteen acres on Leona Heights, outside of the city and separated from it by a steep ridge which will serve to shut off the glare of the city lights. "A street car line runs to within fifty feet of the observatory grounds and within three hundred feet, in an air line, of the observatory site. A good road, from near the station leads around and nearly to the top of the hill. Even now, without grading, an automobile can drive to the very spot where the telescope is to stand.

"The hill is divided from the mountains on the east by a narrow valley about 75 feet deep, while canyons from 75 to 175 feet deep surround the other three sides, forming perfect air drainage."

Mr. Burckhalter writes that everything is going well with the construction of the telescope. The mounting is about ready to ship to the Panama Exposition and the disks for the objective have so far not been delayed by the war.

Actual Time of Signals from the U.S. Naval Observatory, November, 1914.

Day	Time of signals Noon		Time of signals 10:00 p.m.	
	h m s		h m s	
1	11 59 59.97	—.03	9 59 59.97	—.03 Sunday
2	11 59 59.97	—.03	9 59 59.96	—.04
3	11 59 59.95	—.05	10 0 0.01	+.01
4	11 59 59.97	—.03	9 59 59.99	—.01
5	12 0 0.00	.00	10 0 0.00	.00
6	11 59 59.98	—.02	10 0 0.06	+.06
7	11 59 59.96	—.04	10 0 0.02	+.02
8	11 59 59.99	—.01	10 0 0.01	+.01 Sunday
9	12 0 0.01	+.01	10 0 0.01	+.01
10	12 0 0.05	+.05	10 0 0.00	.00
11	11 59 59.99	—.01	9 59 59.98	—.02
12	11 59 59.97	—.03	9 59 59.93	—.07
13	11 59 59.90	—.10	9 59 59.89	—.11
14	11 59 59.89	—.11	10 0 0.01	—.01
15	12 0 0.00	.00	10 0 0.02	+.02 Sunday
16	12 0 0.01	+.01	10 0 0.02	+.02
17	12 0 0.02	+.02	10 0 0.00	.00
18	12 0 0.02	+.02	9 59 59.98	—.02
19	12 0 0.02	+.02	9 59 59.99	—.01
20	12 0 0.03	+.03	10 0 0.01	—.01
21	12 0 0.05	+.05	10 0 0.09	+.09
22	12 0 0.10	+.10	10 0 0.09	+.09 Sunday
23	12 0 0.07	+.07	10 0 0.12	+.12
24	12 0 0.14	+.14	10 0 0.00	.00
25	11 59 59.96	—.04	9 59 59.97	—.03
26	11 59 59.97	—.03	9 59 59.94	—.06 Holiday
27	11 59 59.95	—.05	9 59 59.96	+.04
28	12 0 0.19	+.19	9 59 59.96	—.04
29	11 59 59.96	—.04	9 59 59.92	—.08 Sunday
30	11 59 59.91	—.09	9 59 59.91	—.09

(+) slow (—) fast

Maximum error: Nov. 28, +.19.

U. S. Naval Observatory,
Washington, D. C.
December 4, 1914.

J. A. Hoogewerff,
Captain U. S. Navy
Superintendent.